Financing and economic implications of household energy policies

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Executive summary

1. Introduction

Financing and economic issues play a central role in the formulation of a national household energy policy. In the first place, an orientation towards equity objectives implies that affordability of services for the poor must be increased, possibly through a degree of subsidisation. It is, however, also essential for the long-term viability of the energy sector and its constituent parts, that conventional efficiency criteria are not excessively compromised in attempting to cater to the poor.

Accordingly, this paper has two objectives:

- to assess the *financing requirements* of policy proposals in the main energy sub-sectors and to propose ways of mobilising and allocating finance in areas where this is required, and
- to assess the potential *macro- and micro-economic impacts* of policy proposals, in order to ensure their consistency with broader macro-economic and development goals.

2. The development context for energy investment

The energy sector plays a significant role in the South African economy, particularly in relation to the minerals and manufacturing complex to which it provides important inputs. The *household* energy sector, however, has historically not received much support from the state, either in terms of policy attention or fiscal expenditure. In fact, the bulk of government expenditure in the energy sector has been directed towards increasing energy self-sufficiency and towards building up a local nuclear capacity. Since the early 1970s, the state has expended between 40% and 90% of the Department of Mineral and Energy Affairs' budget on the nuclear industry, with the allocation for 1993/94 amounting to R474 million. As there is limited scope for increases in levels of overall government expenditure, it is more likely that re-allocations will be made within existing budgets to support policies aimed at improving the energy services of the poor. The fiscal grant to the nuclear industry is a potentially important source for such re-allocations.

The energy sector has historically accounted for a large portion of fixed investment in the country, especially due to investments in the nuclear and synthetic fuel industries, as well as electricity power generation capacity. Importantly, these investments are much higher than those required even for the most capital-intensive household energy policies such as electrification.

3. The financing of household energy policies

The financing implications of the five main policy areas in EPRET have been considered separately.

3.1 The financing of electrification

The ability to finance a national electrification programme is critical to its long-term success. At present, problems with the financing of electrification impose severe constraints on accelerated electrification. On the demand side, poor households are generally unable to afford initial connection costs, so that suppliers generally have to finance connection costs and recover those costs through the tariff. However, many local authorities lack any financing capacity, particularly those with supply rights for unelectrified townships.

On the supply side, finance is required for two kinds of expenditure. The first and largest requirement is for the capital connection costs, which, although varying widely from case to case, are currently in the region of R3 000 per dwelling. Secondly, finance is needed to meet the shortfall between revenue derived from electricity sales and the associated costs, especially for levels of consumption which are below the break-even level in a single energy rate tariff system such as Eskom's S-tariff. Clearly, many other factors will influence the total amount of financing required, but an order-of-magnitude estimate of the total capital costs of electrifying 6.6 million households by 2010, which will provide about 86% of all households with access to electricity, will be about R22.4 billion in 1993 Rands.

Sources of finance

There are several important current and potential sources of finance in the electricity supply industry (ESI). These differ between Eskom and other distributors:

- Eskom raises loan finance on local and international capital and money markets. Its total debt stood at about R28 billion in 1992. In 1993, it raised R600 million with the issue of an Electrification Bond. This is an innovative financing mechanism which provides investors with a low initial return, which increases over time as revenue from electrified customers increases, to provide investors with a market-related return over the full life-time of the investment. This kind of mechanism will be important for the financing of accelerated electrification.
- Eskom generates surpluses from its operations; in 1992 its retained income was R1.4 million.
- Many municipal distributors generate surpluses on the trading of electricity; in 1988/89 the national total generated in this way was about R0.9 billion. Moreover, if a national flat-rate tariff is implemented, considerably more revenue will be generated from long-electrified consumers.
- Some municipal distributors raise loan finance from their own development funds, external capital markets or other sources (such as DBSA loans of R230 million in 1992).

It is therefore clear that considerable sources of finance exist within the industry itself. However, notwithstanding these sources of finance, electrification will not proceed rapidly enough under the present structure of the distribution industry, because many local authority distributors (other than Eskom), lack the capacity, as well as financial and political integrity, to raise sufficient funds to finance electrification.

Establish a national Electrification Fund

Consequently it is proposed that a national Electrification Fund be established as soon as possible. Initially this should be managed by the National Electrification Forum (NELF) and, in the longer term, under the control of a national regulator. An Electrification Fund will have two main objectives:

- the *raising of bulk loan and grant finance* for electrification; and
- the *allocation of finance* to increase the level of access to electricity.

The Fund should have two constituent parts: a Loan Fund and a Grant Fund. To illustrate how an Electrification Fund might operate, it is depicted graphically in Figure 1 and described briefly below.

- Firstly, an injection of *seed finance* into the Grant Fund is required, to provide a capital base to act as a loan guarantee fund. The amount could be in the order of R500 million to R1 billion. This should come from the state, but may be supplemented by private and foreign donors.

- This amount could then be used as security to attract large amounts of *loan finance* from private and public investors. Eskom's recent issue of the Electrification Bond is an example of the kind of instrument which can attract private capital on favourable terms.
- Thirdly, the Loan Fund would then on-lend to *distributors* to finance their electrification projects. These loans would be repaid to the Loan Fund by distributors as they recover their costs from subsequent electricity sales.
- The *return* payable to investors in the Loan Fund would be based on a percentage of revenue from domestic electricity sales, subject to a guaranteed minimum rate of return. Any shortfalls between this minimum, and the actual return from electrification would be met from the Grant Fund, and guaranteed by government so as to lower investor's risk further. The effect of this is that low-level consumers (generally the poorest) would be subsidised from this fund.

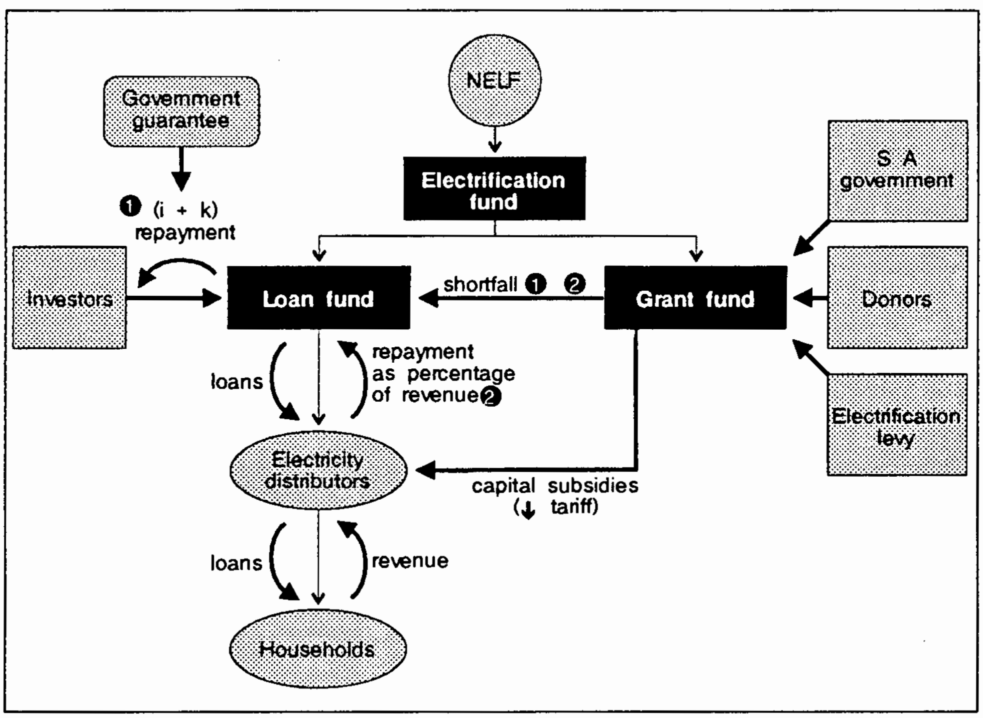

FIGURE 1 Proposed structure and operation of a national Electrification Fund

It is proposed that the guiding principle for the equitable allocation of general subsidy finance (which has not been targeted for specific projects) is that it should be applied to reduce the capital connection costs of poor households. The Grant Fund can be utilised to achieve this objective:

- If the Grant Fund has sufficient resources to meet current and anticipated shortfalls in the Loan Fund, then any additional amounts could be allocated to increase the number of households with access to electricity, by reducing the capital investment requirements to be financed by distributors and ultimately borne by customers.
- In the less probable situation that the Grant Fund still has additional grant finance available after meeting its above obligations, then such finance could be applied to reduce outstanding capital commitments of poor households. This benefit would be passed on to customers in the form of lower tariffs.

The establishment and use of an electrification fund will have several important advantages:

- leverage effects and economies of scale can be maximised by concentrating the bulk financing function in one central point in the industry;
- joint management by the Fund of loan and grant finance would achieve synergies such as through the simultaneous use of the Grant Fund as a loan guarantee fund, to generate income and to attract further capital;
- subsidy finance can be allocated as fairly as possible over time, rather than benefiting only those lucky enough to be electrified at the right time – while subsidy finance is available;
- the impact on price levels will be much smoother than if tariffs were reduced and increased according to the amount and cost of subsidy and loan finance available in any particular year;
- this kind of financing arrangement is not dependent upon any specific structure of the EDI, and, on the other hand, will not constrain the restructuring of the EDI.

Finally, although NELF itself does not have the capacity to manage an Electrification Fund, this could be achieved in the immediate future by the use of existing expertise in various Treasury Departments on an agency basis.

3.2 The financing of fuelwood policies

Policies affecting the fuelwood sector can be grouped into five categories, each with their own financing implications.

- Firstly, policies will attempt to improve the *management of natural woodlands*. This will depend largely upon extension work by existing networks of rural development non-governmental organisations (NGOs) and various levels of government. As such, the financing requirements associated specifically with this policy will be relatively small.
- The bulk of additional firewood production should come from a *social forestry* programme. For an annual yield of 400 000 to 600 000 tons of firewood, a network of about 4 000 small nurseries may be required at a start-up cost of about R83 million and annual costs of about R40 million.
- Thirdly, a network of about 1 500 *woodlots* could produce a similar amount of wood once established and can be relatively self-sufficient once wood is being sold. At an average establishment cost of just under R3 000 per hectare, total establishment costs will be in the region of R260 million.
- Commercial *small-grower schemes* which are operated by forestry companies to encourage small farmers, could expand their scope considerably. For a target of 60 000 hectares, establishment and management costs over the first rotation period (roughly eight years), borne initially by forestry companies and partly recovered later, would be in the region of R156 million in total.
- Finally, the *transport* of fuelwood from areas with surpluses to areas in which demand is high could make considerably more firewood available to households. These costs would be financed by traders.

3.3 The financing of a low-smoke coal programme

In recognition of the likelihood that newly-electrified households, particularly in the PWV, will continue to use coal for energy-intensive services such as cooking and heating, it has been proposed that a *low-smoke coal (LSC) programme* be launched to eventually eliminate highly-polluting bituminous coal. In order for households to switch to LSCs these may require a price advantage (at least initially), and this may require some kind of subsidy. This can be achieved by providing a direct subsidy to manufacturers, or by taxing conventional coal and cross-subsidising LSC. Moreover, one of the prototypes currently being evaluated is relatively labour-intensive and can easily be manufactured by small-scale enterprises, co-operatives, or households – thus also having employment spin-offs. The amount of the subsidy required to completely replace conventional coal in the domestic market, will be a maximum of about R180 million per annum, but will probably be much less. Even at this level, a tax of R1 per ton on conventional coal (3% of domestic coal prices and 1.2% of export prices) would be sufficient to finance the subsidy.

3.4 The financing of paraffin and gas policies

From a financing perspective, there are two areas where paraffin and gas policies will be significant. The first relates to the extension of marketing and distribution *networks* into areas presently unserviced by oil companies and distributors. Generally these investments will be undertaken by private sector companies, such as the oil majors, and will be normal commercial investments.

The second area relates to the production of *child-resistant lids and containers* for the storage and transport of paraffin, so as to reduce the risks of paraffin poisoning in infants. Current research by the Medical Research Council indicates that child-resistant lids can be produced at a low cost (of around R1 each), which could make this a financially viable, as well as employment-creating, programme.

3.5 The financing of energy efficiency policies

In general, most DSM policies entail an initial investment which results in reduced cash outflows in subsequent periods. Consequently, the barriers posed by high initial investment costs may prejudice those who lack sufficient resources or access to credit for making such investments. This suggests that utilities have an important role to play in financing DSM programmes.

Two of the policies proposed in EPRET will have fairly significant financing requirements. Firstly, a programme to improve the *thermal performance* of houses would require a moderate investment in ceilings and insulating materials for each dwelling. Likewise, a programme to encourage the use of energy-efficient *appliances* such as compact fluorescent light bulbs will require initial finance, for example from Eskom or appliance manufacturers, which can then be recovered over time through the electricity tariff. Provided the energy saving is sufficient, households should pay less for their energy, even with higher tariffs.

Secondly, the implementation of *time-of-use (TOU) tariffs* will require the installation of appropriate meters. Currently these cost in the region of R1 000 each, although costs are likely to fall, as they did with prepayment meters.

4. Impacts of policies on the macro-economy

4.1 Impacts on levels of investment

A national *electrification* programme which seeks to provide access to around 86% of households by 2010, would have to make about 6.6 million connections over the ensuing 17 years at a total cost of about R22.4 billion (in 1993 Rands). The peak annual investment, for 500 000 connections, will amount to about R1.5 billion, which is equivalent to 2.9% of the country's GDFI for 1992.

In the *fuelwood* sector, investments will be made by forestry companies in small-grower schemes, to the extent of about R80 million initially. Related maintenance and extension expenditures are considered in section 4.2 below.

Demand-side management strategies also have fairly sizeable investment requirements. If one million electricity consumers switch to Time-of-use tariffs and require the appropriate meters, then total investment requirements will be between R600 and R1 000 million. Similarly, if each of three million electrified households are to use efficient appliances such as compact fluorescent light bulbs, investments will be in the region of R240 million. Even more significant may be the investments in improved thermal performance of dwellings. For example, if an investment of R750 is made for all informal and 50% of formal dwellings in cooler climatic areas, then investments will total R1.35 billion.

Clearly, the investment requirements of energy efficiency are not insignificant. On the other side of the coin, however, are the *decreases* in investment resulting from policies such as the DSM strategies proposed. Whilst these have not been quantified, they are likely to be highly significant when the costs of expanding power generation capacity are considered.

4.2 Impacts on fiscal revenue and expenditure

An accelerated *electrification* programme will require some government expenditure which will, however, be partially offset by inflows due to increased taxation on income and expenditure associated with the programme. If the state is to subsidise the excess of connection costs over the 'cost of connection parameter' (which will be the maximum amount to be financed by utilities), then it is likely that this obligation will be greatest in respect of more remote and dispersed rural households. Assuming that one million households fall into this category (almost one-third of all rural households) and that connection costs will average R6 000 each, then the state's total commitment will be about R2.5 billion over the 17 years of the programme, peaking at R270 million at the height of the rural electrification programme.

It was stated earlier that the fiscus should guarantee any shortfalls between the minimum returns offered to investors in the Electrification Fund, and actual revenues derived from newly-electrified customers. Provided the state makes an initial grant to the Fund of at least R500 million as seed finance, then this shortfall could be fully met from the income generated by the seed finance. Consequently, no 'operational' subsidies would be required from the fiscus.

On the other hand, inflows to the fiscus due to income taxes and VAT associated with direct expenditure on electricity connections would amount to about R200 million at the height of the programme. Taking these inflows into account therefore reduces the net demand on the fiscus for electrification.

Fuelwood policies comprising social forestry and woodlot programmes will require expenditure by the state of about R130 million per annum. Whilst this may seem large in relation to the fuelwood sector, it must be noted that the scale of the interventions proposed are ambitious and will affect many people.

Subsidisation of *low-smoke coal* will cost, at the most, about R180 million per annum. However, production costs of these fuels can be considerably lower and, moreover, any subsidy which is required, could be fiscally-neutral by imposing a small tax on conventional coal to provide LSC with a price advantage. Furthermore, any expenditure which the state does incur on such a programme will also have an employment dimension in respect of any additional jobs created.

The amounts being considered here can be placed in perspective by noting that the Department of Mineral and Energy Affairs budgetary grant for 1993/94 was R708 million and the grant to the nuclear industry was R474 million. Clearly, then, these policies which will have a material impact on the living conditions of the poor, must have a high-ranking claim on fiscal resources.

4.3 Impacts on the Balance of Payments

A national *electrification* programme will result directly in small outflows on the current account in respect of the import of certain materials required for the connection process and for some electrical appliances which households are likely to acquire. Together, it is estimated that these will amount to about R250 million at the peak of the programme. This represents only about 0.5% of 1992 imports. On the other hand, it is possible that local manufacturers may benefit from economies of scale and from experience associated with a large-scale electrification programme, and capture increased export markets. This is possible particularly for prepayment meters.

The only other balance of payments impact of note relates to the import of electric appliances such as compact fluorescent light bulbs. As these are fully imported at present, almost all expenditure on these would leave the country.

4.4 Impacts on employment

This section considers only the direct and formal employment opportunities which may result from the policy proposals. In the case of *electrification*, it has been estimated that about 16 000 formal jobs may be created *directly* by the programme, although it is clear that many more opportunities will arise through related spin-offs and multipliers, especially in the informal sector.

In the *fuelwood* sector, the establishment of social forestry programmes, woodlots and an increase in extension work will result in significant employment benefits. A very rough estimate is that about 16 000 new jobs would result from the proposals in this sector.

The production of *low-smoke coal* is, similarly, potentially labour-intensive, and it is possible that about 11 000 people could be employed in decentralised manufacturing enterprises supplying half of the domestic coal market. Similar benefits could result from the manufacture of child-resistant paraffin lids and containers in small-scale manufacturing concerns.

4.5 Impacts on environmental sustainability

The policies proposed in EPRET are not concerned with *long-term* environmental sustainability *per se*, although many policies are motivated partially or fully by the need to improve the immediate environmental conditions experienced by poor households. The combination of electrification, LSC, fuelwood policies, child-safe paraffin containers and energy efficiency measures will result in many *environmental benefits*, particularly at the local scale. To the extent that improvements must be effected at a local level before larger sustainability questions can be considered, it is clear that these policies will make a positive contribution to overall environmental quality.

5. Impacts of policies on the electricity supply industry

Of all the energy sub-sectors, the EPRET policy proposals will have the most significant economic impact on the *electricity* supply industry. Consequently, the effects of the proposed electrification programme, together with related proposals around tariffs and ESI structure, have been calculated using a financial model developed for this purpose. Several assumptions have been made for the purpose of this exercise, details of which are contained in Chapter Five of the paper. The most important assumption relates to the domestic tariff, which is assumed to be a national tariff of 20 c/kWh (excluding VAT).

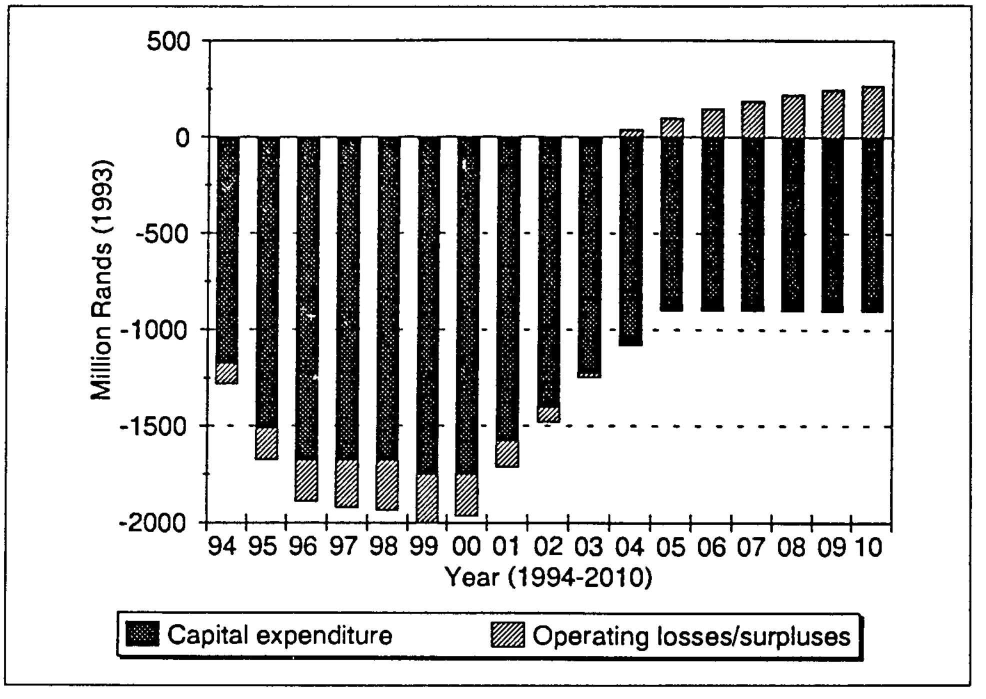

FIGURE 2 Annual capital expenditure and operating losses/surpluses of the electrification programme

Electrification programme financing requirements

Based on a flat-rate tariff of 20 c/kWh for all new customers, then the *total financing requirement* over the 17 years to 2010 will be in the region of R22.4 billion. This, in turn, can be divided into capital expenditure of R21.9 billion, and cumulative operating losses by 2010 of R0.5 billion. While the programme as a whole will therefore not have broken even by 2010 with respect to operating flows, it is also significant to note that after 2003 the programme generates an operating surplus. This is shown in Figure 2.

Financing electrification with pooling of wealthy consumers

The financing requirement of the electrification programme will be considerably reduced by the introduction of a national flat-rate tariff system which applies to *all* consumers, including long-electrified wealthy households. Assuming that the additional revenue generated by these consumers shifting onto a tariff of 20 c/kWh is available to the industry, but is phased in over four years to ease the burden on those consumers, then the *peak financing requirement* of the programme will be reduced from R22.4 billion to *R9.9 billion*. This peak would be reached after 11 years in 2004, with large operating surpluses (attributable to high-level consumers) as shown in Figure 3.

This financing requirement is of a relatively manageable magnitude, being more or less equivalent to the cost of one power station. The impact of this on the *debt levels*

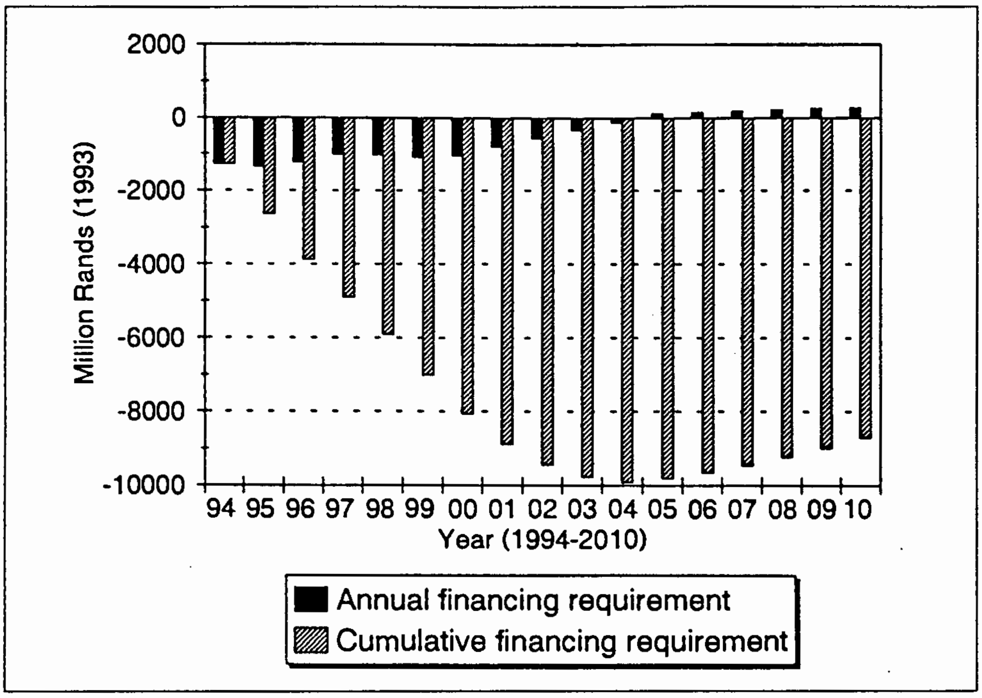

FIGURE 3 Cash flows of electrification with phased pooling of high-level consumers

in the ESI, or on Eskom if it were to take on the whole distribution function (that is, there is one national distributor), would be easily manageable. Assuming that Eskom achieves its goal of 1:1 debt:equity ratio by 1996/97 (without the effect of electrification), that it aims to maintain its debt at par with its equity thereafter, and that earnings grow at a modest 8% per annum, then at the peak of the electrification programme's debt requirement in 2004, its debt:equity ratio would be about 1.2:1. In other words, electrification will have only a small negative effect.

A *sensitivity analysis* of the major variables in the electrification programme shows that by far the most sensitive variable is the *tariff level*. A 10% decrease in the tariff to 18 cents per unit (net of VAT) *increases* the peak financing requirement to R13.6 billion: a 153% increase over the scenario in which pooling occurred. Even after 17 years in 2010, annual cash flows would still be negative. Conversely, an increase in the tariff to 22 c/kWh almost eliminates the need to take on any debt at all: maximum debt levels would be only R258 million, a 95% reduction. Clearly, therefore the setting of the tariff level is a crucial process insofar as the long-term viability of the ESI is concerned, which underscores the need for a strong regulatory environment in which sound financial and economic policies are followed by electricity utilities.

6. Impacts of policies on household micro-economies

Poor households typically spend a high portion of their income on energy services, and it is not unusual for the poorest urban households to spend between 10% and 25% of their incomes on energy. Even in rural households, where fuelwood is the main energy source and is by-and-large available at no cash cost, energy expenditure may still be significant where households use batteries, candles and paraffin. Moreover, even where incomes are low and erratic, energy expenditures are not easily reduced, as evidenced by the relatively high percentage of income devoted to energy by poor households.

On the whole, the policies proposed in EPRET will have a *positive* effect on the micro-economies of poor urban and rural households, although it is difficult to quantify these effects. In the case of *electrification*, a national flat-rate tariff will have a variable effect on consumers. For currently unelectrified consumers, expenditure on electricity for lighting, media and other small energy services will probably be lower than on candles, batteries and paraffin for the equivalent services. For long electrified consumers, who are paying much lower tariffs (averaging around 15 c/kWh), electricity expenditure would increase. For a household consuming 800 kWh per month, a national rate of, for example, 20 c/kWh excluding VAT would translate into a R46 increase (including VAT) in their monthly electricity bill, equivalent to a 33% increase. Since this consumer group is generally more wealthy, this cross-subsidy would be progressive from an equity perspective. Such increases could, however, be mitigated by a shift to time-of-use tariffs, if households are able to use electricity more efficiently.

Expenditure on *low-smoke coal* should, in principle, be lower than on conventional coal, the price of which may be increased by the tax referred to earlier. If *paraffin and gas* policies are effective in reducing end-prices by the amounts anticipated, then savings for typical households might amount to about R8 per month for each fuel. *Fuelwood* policies are unlikely to have any major effect on the budgets of households which rely on wood. *Demand-side management* policies, on the other hand, should result in lower energy expenditure, due to the net amount of energy which may be conserved, or to the more efficient use of energy, such as electricity out of peak hours.

7. Conclusion

On the whole, it is argued that the EPRET policy proposals will result in real benefits to poor urban and rural households which are the targets of these policies. These benefits will take the form of improved physical access to electricity, low-smoke coal, paraffin, gas and fuelwood, together with more affordable pricing of associated energy services. Moreover, these equity gains can be achieved within the overall constraints of the macro-economy and without jeopardising the financial viability of institutions such as those in the electricity supply industry.

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CHAPTER ONE

Introduction

South Africa currently faces a situation in which access to adequate energy services is very unequally distributed among its population, with this inequality in many respects a mirror of the political and economic differentiation produced by apartheid. At the same time the country also has the capacity, extremely unusual in developing countries, to bring about a real improvement in the living conditions of the poor, through policies aiming to widen their access to adequate and affordable energy services.

In formulating a national household energy policy, financing and economic implications play a central role. On the one hand, the orientation towards equity objectives implies that affordability must be increased for the poor, which may necessitate a degree of subsidisation. On the other hand, it is also essential for the long-term viability of the energy sector and the national economy in which it plays such a dominant part, that conventional economic efficiency criteria are not too heavily compromised in attempting to cater to the poor.

Consequently, the financing requirements and economic impacts of household energy policies act as important points of reference and as potential constraints on the policy proposals. It is necessary, in developing policy options, to assess their financial implications, and whether they are realistic and feasible in the light of the limited available resources. In this way, it is important to assess the economic impacts of policy proposals on a number of levels: on the national economy, on energy subsectors and industries, and on households themselves. Where the economic impacts are unrealistic or in conflict with the objectives of the exercise, an iterative process may be required whereby policies are revised until they become consistent with economic realities.

This paper forms part of the South African Energy Policy Research and Training (EPRET) project, a two-year research programme conducted at the Energy for Development Research Centre of the University of Cape Town. In recognition of the problems currently experienced in the household energy sector, and of the potential for effecting real improvements in these conditions, the project aims to identify policies which will widen access to basic energy services for the urban and rural poor in South Africa. The project comprises 23 sectoral studies, covering demand, supply and cross-sectoral themes, one of which is the financing and investment area.

The two objectives of this paper are:

- to assess the financing requirements of policy proposals in the main energy subsectors and to propose ways of mobilising and allocating finance in areas where this is required; and
- to assess the potential impacts of policy proposals on important macro- and micro-economic variables, in order to ensure the consistency of policy proposals with broader macro-economic and development policy conditions.

The paper begins by contextualising energy investment and expenditure in the macro-economic and micro-economic environments currently operating in the South African energy sector. In Chapter Three the financing arrangements for each of the main policy sectors are addressed. These sectors include electrification, fuelwood, low-smoke coal, gas and paraffin, and demand-side management. The current financing arrangements are described, estimates are made of the approximate amounts required to finance the policy proposals in each sector, and, where necessary, specific proposals are made regarding potential sources of additional finance. In the case of electrification, additional attention is devoted to possible mechanisms and institutions for the raising and allocation of finance.

Following this attempt to quantify the investment requirements of the main policy sectors, Chapter Four undertakes an assessment of the order-of-magnitude macro-economic impacts of each policy sector. This is done for two macro scenarios: a business-as-usual scenario in which current trends in the energy sector continue, but without any further major interventions; and, secondly, an integrated energy planning (IEP) scenario in which policy proposals aimed at widening households access to energy services are implemented. The macro-economic variables which are considered include investment levels, fiscal revenue and expenditure, the balance of payments, employment levels and environmental quality. The latter two variables, whilst not always included in such analyses, are relevant in the light of the importance attached to equity and environmental sustainability objectives in energy planning.

Chapter Five considers the impact of the IEP policy scenario on the electricity supply industry. This sector is singled out because of the scale of investment implied by the policy proposals. A financial model which was developed for this purpose is used to quantify the financial impacts on the industry and to assess the sensitivity of the outcomes to changes in the most important variables.

Then follows a brief consideration of the potential impacts of policy proposals on household micro-economies. This is a much more qualitative analysis than those preceding it, because of the relative absence of data on household incomes and energy expenditures, and the wide variances which occur across space and time.

CHAPTER TWO

The development context for energy investment

2.1 Introduction

The economic environment prevailing in South Africa at present and in the coming decade will have a fundamental influence on household energy financing and investment. The rate of economic growth, levels of government expenditure, the balance of payments situation, the rate of domestic investment, and many other variables will have a direct impact on the availability of funds for investment and expenditure on energy services, within both the public and private sectors. In turn, the resources which are devoted to new energy investments will impact upon many of the variables. If, for instance, large sums are directed towards a national electrification programme, this investment will have an impact upon the broader economic environment. Consequently, the energy policies proposed in the EPRET project will be influenced by, and will have an influence upon, South Africa's broader development context.

It is therefore necessary to locate the financing and investment implications of household energy policies in the broader economic context. Inherent in a policy research and formulation process should be an iterative process of assessing whether the resource requirements of the policies can realistically be met from available resources within a changing economic context. This chapter therefore sets out to describe the wider economic context which currently exists and which is likely to exist in the near future, as it impacts upon the energy investments proposed by the EPRET project. The issues addressed in this chapter are more specific than those covered in EPRET Paper 3, *The development context for energy planning in South Africa*, which described the general development arena as it pertains to all sectors of the country.

One aim of this chapter is to identify the potential for government, individual and other sources to supply the necessary investment capital. The chapter has four main sections: first, a description of the macro-economic environment related to energy planning; secondly, a brief description of some key micro-economic considerations related to household income and energy expenditures; thirdly, several principles are offered which, it is suggested, should guide the subsequent analysis of financing sources for household energy policies; finally, a brief description of two household energy scenarios which are used to assist in analysing (in subsequent chapters) the financial and economic impacts of policy options.

2.2 The macro-economic context of energy investment and expenditure

It is clear that government in South Africa will increasingly have to address the demands of the newly enfranchised electorate for improved social and private services, such as education, health care, water and sanitation services, housing and social security. These demands are likely to be given expression in many forms and at all levels of government. At the same time the government has to manage, and attempt to reverse, the current economic crisis: unemployment of nearly 50%, a trend of negative economic growth, a large budget deficit (nearly 9% of GDP), and low levels of investment. Indeed, it has been suggested that the combination of these economic and other factors means that South Africa enters the next stage of transformation to a political democracy on a very weak economic and social footing

(Tucker & Scott 1992). It is probably not even correct to say that a democratic government will have to 'maintain' macro-economic balance, because the economy is currently in, or close to, a state of imbalance.

While the state of the macro-economy is currently not conducive to ambitious energy investments there are, nonetheless, many potential sources of finance to which the energy sector has, or can gain, access. One possible avenue, the potential for the state to increase expenditure levels or to divert them towards the energy sector, will be explored below.

2.2.1 Current and future fiscal expenditure

The functional breakdown of general government expenditure for 1982/83 and the most recent estimate for 1993/94 is shown in Figure 2.1. It is clear that significant shifts have occurred during this period, the most significant being the decreases in allocations to defence and economic services (which includes roads, agriculture and manufacturing), and the increases in education, social services (such as pensions), and 'other' (due mainly to increases in finance charges).

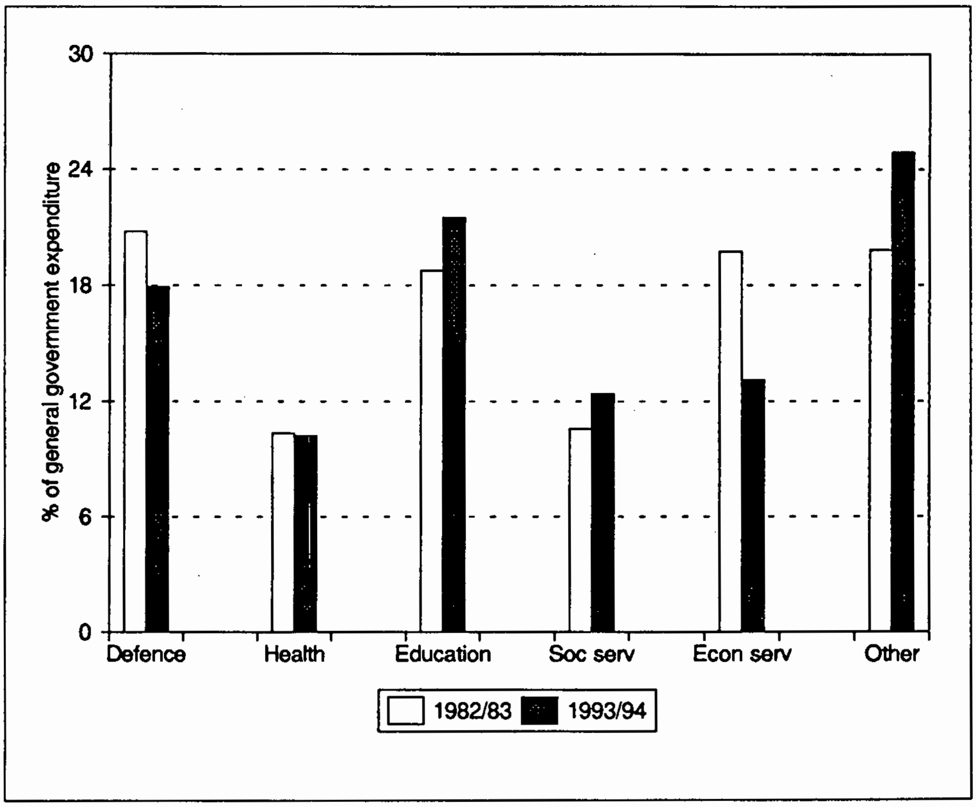

FIGURE 2.1 Functional classification of general government expenditure, 1982/83 and 1993/94 (CSS 1990, 1993)

It has been argued that there is little scope for the government to *increase* expenditure levels significantly, without jeopardising macro-economic balance further (Van der Bergh 1991: 85). While additional revenue-raising mechanisms such as capital gains taxes have not yet been implemented in South Africa, the overall tax burden on the economy is already fairly high and offers little scope for large or rapid increases (Loots 1991: 56). Taxes such as a capital gains tax are unlikely to collect significant amounts for the fiscus. Interesting options exist, however, for the government to raise additional sources of revenue within the energy sector. The levy on petroleum products is traditionally a major source of revenue in many countries. In South Africa, the fuel levy amounts to roughly 50% of the petrol pump price, and raised R8 billion in 1992/93, or 10% of fiscal revenue (EDRC 1993: 63).

Other energy subsectors, however, are not taxed in a similar way, even though a relatively small percentage increase could generate considerable government income. For instance, a 5% surcharge on wholesale electricity prices would be relatively easy to administer and would have generated gross revenue of about R633 million in 1992, based on Eskom's sales volumes and wholesale prices (Eskom 1993a: 2). Likewise, a 5% surcharge on coal prices would have raised R223 million from domestic coal sales in 1991 and R213 million from export coal sales (DMEA 1992: 27).

These amounts are not insignificant, and are of the same order of magnitude as the costs of the policies proposed in this project. Clearly, it would be essential to investigate the effects on consumer price levels of such taxes, as well as their distributional effects, since such indirect taxes may have greater negative effects on the poor than more specifically-targeted mechanisms aimed at wealthy individuals and companies. Further, such taxes may disadvantage South African producers in relation to international competitors, especially in the short term, although the converse could also occur in the longer term, when price increases in historically cheap products may encourage greater efficiency and competitiveness. Consequently, for government to seriously consider the imposition of additional taxes and levies on other energy commodities such as electricity and coal, it would have to weigh the benefits of additional revenue against the costs flowing from higher prices to individual and corporate consumers. Nonetheless, scope may exist for appropriation of revenue from such sources.

Aside from such options, the main prerequisite for an increase in government revenue, is rapid economic growth. In the short term, therefore, the main option for government seeking to increase redistributive expenditure, will be to alter the *composition* of the budget. It is possible to gain an idea of the potential to effect such shifts within the current budget structure, by comparing South Africa's pattern of government expenditure with those of other middle-income countries such as Brazil, Mexico and South Korea. These are shown in Figure 2.2.

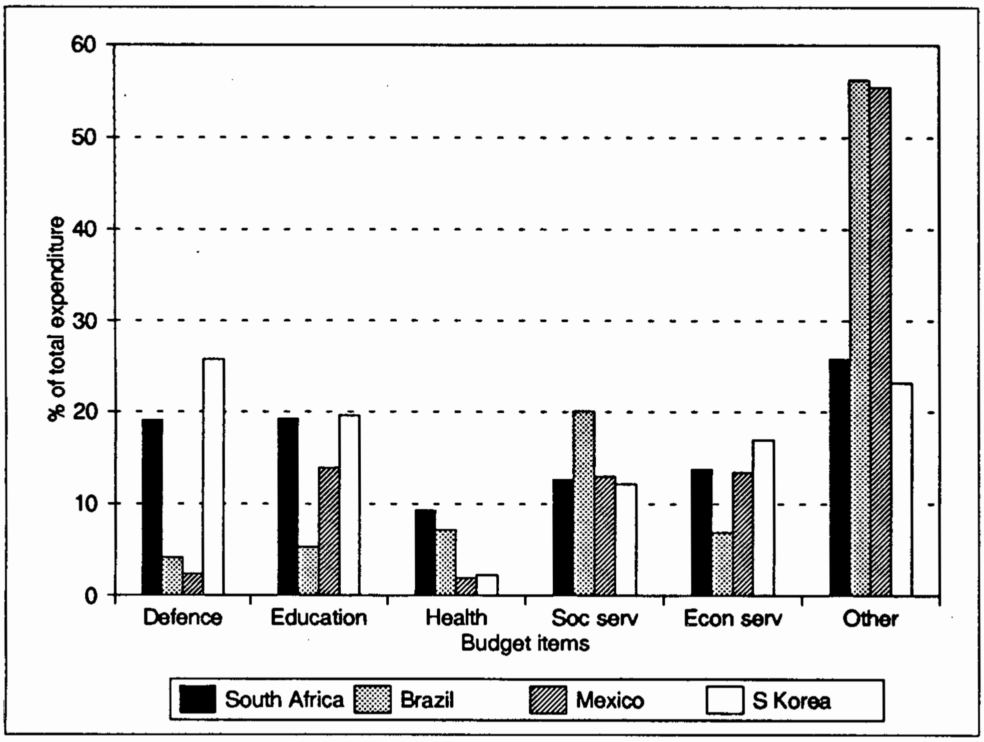

FIGURE 2.2 Government expenditure by South Africa and other middle-income countries in 1990
(CSS 1993; World Bank 1992: 239)

It is apparent that South Africa's level of expenditure on social services (education, health and social security) is comparable to, or even higher than, those of other countries with similar income levels and economy sizes. This suggests that relatively limited increases are possible in levels of expenditure on social services. Whilst it may be expected that further cuts could be achieved in the defence function, sometimes referred to as the 'peace dividend' (van den Bergh 1991: 82), this is not likely to be very significant. The portion of this budget allocated to the Defence Force has been decreasing steadily since the peak during the Angolan war, while the portion allocated to police and prison services has been increasing rapidly. Given the current levels of violence, and assuming that these will not disappear overnight, future savings in this area may be less significant than hoped.

This notwithstanding, there remains considerable scope for allocating existing budgets in a more efficient and equitable manner. In particular, the fiscal allocation to the Department of Mineral and Energy Affairs (DMEA) offers this potential.

2.2.2 Trends in the budgetary allocation to the DMEA

The budgetary allocation to the DMEA is included under the 'economic services' functional allocation. The Department's budget for 1993/94 was R708 million (SA Treasury 1993: 17-1), equivalent to only 0.5% of total budgeted government expenditure for the year. The historical trend in the DMEA's budget allocation is shown in Figure 2.3 in nominal and real terms.

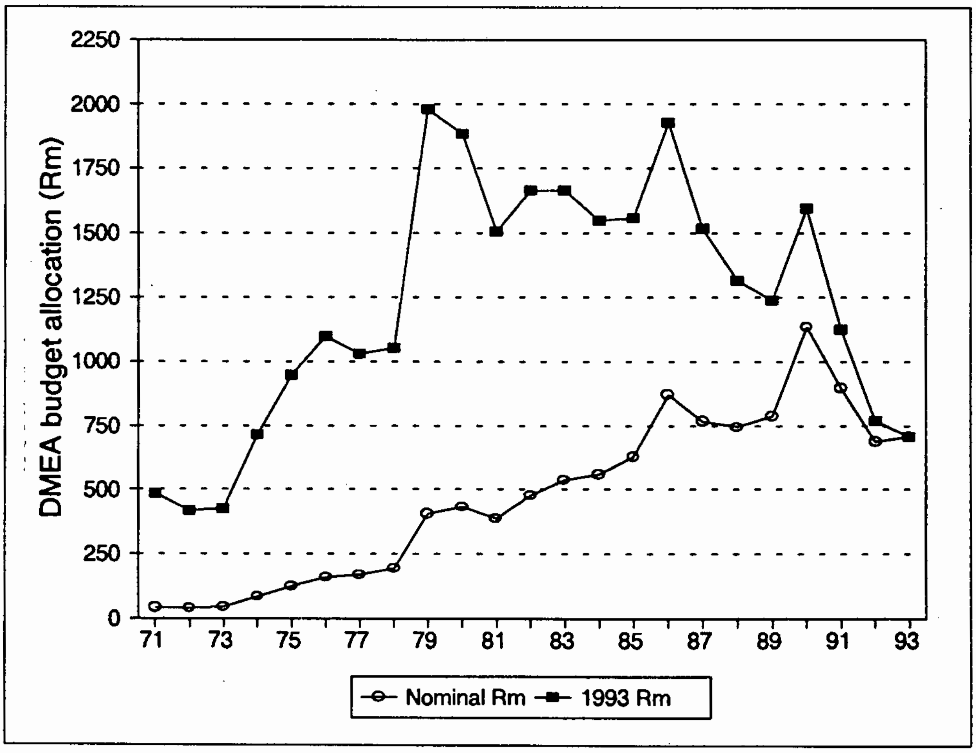

FIGURE 2.3 Trends in fiscal allocation to the Department of Mineral and Energy Affairs, 1971/72 to 1993/94
(Auf der Heyde 1993)

By far the largest beneficiary from the DMEA's budget allocation over the past 20 years or more has been the nuclear industry. The portion of the Ministry's funds allocated to the nuclear sector increased from 40% in 1971/72 to a peak of 89% in 1986/87 when the nuclear weapons programme was underway (auf der Heyde 1993). At present, this portion has dropped to around two-thirds of the budget. The trend in the portion of the DMEA (prior to 1978 the Department of Mines) budget which has been allocated to the Atomic Energy Corporation (AEC) and other nuclear agencies is shown in Figure 2.4.

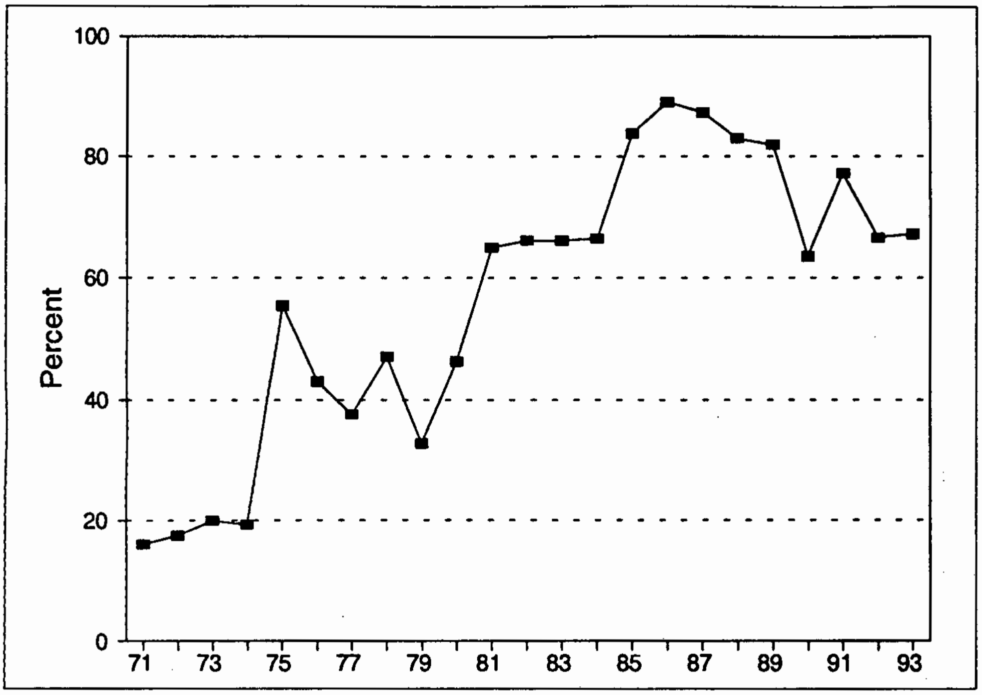

FIGURE 2.4 Percentage of DMEA budget allocated to nuclear industry, 1971/72 to 1993/94
(Auf der Heyde 1993)

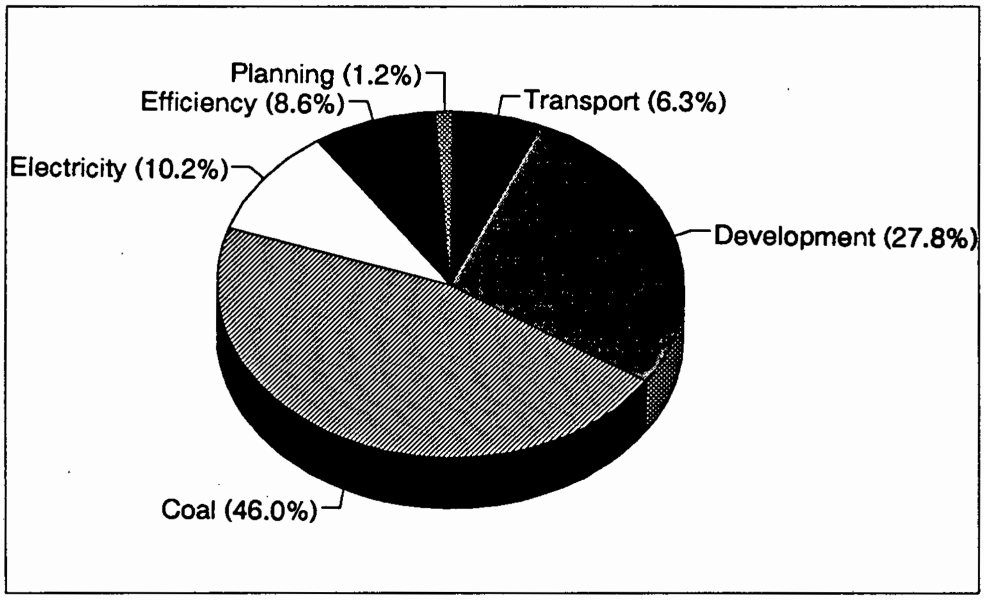

FIGURE 2.5 Breakdown of DMEA energy expenditure (excluding nuclear industry) for 1991/92
(NEC 1992)

Moreover, it is highly questionable whether these huge accumulated investments in the AEC have delivered benefits which are justifiable from an national perspective. If the main motivation for the AEC's existence has been to support nuclear electricity generation, then its output has been singularly disappointing: fuel for four of the nine years of Koeberg's operation to date, and then only for one of its two reactors, and this a cost premium in relation to imported fuels (Eberhard & van Horen 1993: 33). Not only has the state subsidised the production of nuclear fuels, but it has also financed the development of at least six atomic bombs. Clearly, therefore, fiscal support for the AEC over more than 20 years has been very expensive and has produced little value added in return. This is an important area in which state expenditure can be re-allocated towards socially and economically productive purposes.

Of the total budget allocation for 1993/94, approximately 29% was allocated to the minerals section, 67% to the nuclear industry and the remainder to the non-nuclear energy sector. Most of the budget allocation to the energy branch is spent on the coal sector, although the energy for development sector (concerned mainly with household energy issues) is receiving a growing share of the total budget. The breakdown for 1991/92 expenditure by the energy branch (excluding nuclear energy) is shown in Figure 2.5.

The total of the items shown in Figure 2.5 represented only 3% of the DMEA's total budget for that year. It is therefore apparent from the previous figures that a considerable portion of government energy expenditure is directed towards supporting the nuclear industry's operations, whereas only a very small percentage (less than 1% in 1991/92) is aimed directly at household energy policy. It has been argued that this allocation is not justifiable on efficiency, equity and sustainability grounds (EDRC 1993). There is therefore considerable scope for more effective utilisation of the DMEA's budgetary resources. This is important in relation to, for example, the need for subsidy finance for specific areas such as rural electrification and low-smoke coal development (as discussed later in this paper).

2.2.3 Current levels of energy investment and expenditure

As in many other countries, the energy sector accounts for a significant portion of total capital investment in the national economy. When the energy sector is evaluated together with the minerals and related industrial sectors, as part of the minerals-energy complex (MEC), then its role in the economy becomes even more significant. According to Rustomjee (1992), the MEC accounts for around 25% of total GDP, considerably more than the manufacturing sector's 15% contribution. Alternatively, total energy sector investment can be disaggregated according to the major commercial energy subsectors: electricity, petroleum and coal. Likewise, the level of government expenditure in each of the sectors will be addressed below.

The electricity sector

The main institutions making direct investments in the electricity sector are Eskom and the myriad of municipal distributors. Apart from general investments in fixed property and operating assets, two categories of investment can be identified for present purposes: expansion to generation capacity, and extension of the domestic electricity grid to previously unelectrified households. Capital expenditure by Eskom on power stations has, in the past, been responsible for a very significant portion of Gross Domestic Fixed Investment (GDFI). At its peak in 1985, Eskom's capital expenditure was R5.25 billion, or, if inflated at 12% per annum, the equivalent of about R13 billion in 1993 (Eskom 1992: 43). This represented 18% of GDFI in 1985 (SARB 1991: 58). This level of investment, however, has declined considerably because of the over-capacity on the national system, and in 1992 Eskom invested about R3.6 billion (less than 25% of the 1985 peak). This represented a more modest 7% of 1992 GDFI (SARB 1993: 92).

The second category of capital expenditure in the electricity sector, is for the connection of unelectrified dwellings to the national grid. In 1992, about 200 000 new connections were made at a total capital cost of approximately R600 million. Eskom accounted for roughly three-quarters of this, with municipal distributors responsible for the remainder. At present rates of connection, therefore, the capital requirements for electrification are relatively small in relation to historic levels of investment in power stations. Even if the connection rate is increased to 500 000 per year, the capital requirements for these connections will still be considerably less than the investment required for a large coal-fired power station.

While most electricity institutions are in the public sector, the state has historically not played any significant direct role in the financing of investment. Generally, the electricity institutions are sources of net surpluses, which, in the case of Eskom have been retained and reinvested, and, in the case of white municipal electricity distributors, have usually been applied to subsidise other municipal services. One exception to the general rule of no state expenditure on electricity are the government subsidies to Eskom in respect of the connection costs of a number of white farmers, who were electrified for the apartheid government's political reasons.

The petroleum sector
In contrast to the electricity sector, most institutions in the petroleum sector are in the private sector. The exceptions to this are the synthetic fuel corporations: Mossgas and, until fairly recently, Sasol – these will be dealt with later.

The petroleum companies are responsible for significant amounts of capital investment, in respect of refineries and other fixed assets. Apart from the Sasol and Mossgas plants, there are four refineries in Cape Town, Durban and Sasolburg, representing total investments of several billion rand. In 1992, expansions to these refineries entailed new investment of about R700 million, which was financed by a combination of retained earnings and local and foreign capital(EDRC 1993: 58). It is anticipated that investment by these oil majors in the period 1992 to 1995 will be in the region of R6.6 billion (EDRC 1993: 58).

The synthetic fuel industry, on the other hand, has benefited from considerable transfers from the public sector since Sasol I was established in the early 1950s. All three Sasol plants were financed, at least partially, by the fiscus, at a total estimated cost (in 1985 Rands) of about R10 billion (Eberhard & Trollip 1992: 14). In current terms, this investment is equivalent to more than double the 1985 nominal cost. In the case of Mossgas the total capital cost, according to the Minister responsible, was almost R11 billion (Bartlett 1993: 11). At the peak of Mossgas' construction, it accounted for 6% of the country's GDFI (Scott et al 1992: 13). The efficacy of both synfuel operations has been questioned, as both were motivated largely by the state's desire to achieve greater self-sufficiency in the face of international censure of apartheid (Eberhard & van Horen 1993). The Mossgas project in particular is uneconomical at currently prevailing oil prices, and a recent report by the Auditor-General acknowledges that the original loan from the state is unlikely to be repaid.

Not only have the synfuel operations received direct capital investment from the public sector, but they also enjoy operational subsidies to cover the excess of their production costs over the current oil prices. While Mossgas has only recently come onstream, Sasol has received these subsidies for many years. In essence, Sasol is guaranteed a floor price of $23 per barrel for its synfuel production, whereas actual prices have generally been well below this level. It has been estimated that the total transfer from end-users of petroleum products to Sasol in 1992 was about R450 million (EHR 1993: 24), representing a subsidy to Sasol of 10.8 c/litre of its production, and a premium of 3.4 c/litre on all petrol sold in the country. While the synfuel industry has created positive spin-offs in addition to the foreign exchange saved, such as Sasol's petrochemical operations, these have been very expensive.

The coal sector
The coal sector plays a central role in the South African economy. Coal is the feedstock for over 80% of the country's electricity and for the Sasol synfuel process. It is also a significant foreign exchange earner, and in 1992 was the second largest contributor (R4.3 billion or 15%) to minerals export revenue (excluding diamonds) after gold (R18.8 billion or 64%) (von Glehn 1993). From an investment point of view, however, the coal sector is presently not in an expansionary phase, and current levels of investment are much lower than in past decades. Moreover, capital for investment purposes is derived from the private sector.

Consumption of coal by households represents a very small proportion, less than 2%, of the total volume of coal sales, and even less by value. Consequently, there are no major investment implications of household coal consumption relevant to this discussion.

2.3 The micro-economic context of energy investment and expenditure

The levels of household investment in energy-related assets and expenditure on energy services is highly variable across the population. Even among the focus group of the present study, the urban and rural poor, these levels vary widely. Moreover, the availability of income and expenditure data, and its accuracy, is less than ideal.

Nonetheless, several important generalisations can be made. Firstly, poor households generally spend a higher proportion of their income on energy than wealthier households, suggesting that energy displays income-inelastic characteristics. In other words, energy is an essential service, or a basic need, so that a lack of choice regarding energy use will exacerbate constraints operating on the poor. Secondly, income flows in many poor households tend to be erratic and inconsistent. This makes it difficult for them to meet regular financial obligations, such as monthly rent and service payments, or repayment of credit. This has important implications for methods of pricing, financing and delivery of energy services, and is one reason, for example, why many poor households prefer prepayment-metering for electricity – they are able to consume only as much as they can afford. Thirdly, access to credit is generally very low for poor households. Institutions in the formal lending sector obviously view poor households as high-risk customers and accordingly require high rates of return to compensate them for this risk, or refuse to provide credit. As a result, many poor households rely on informal saving and lending associations (such as 'stokvels') to finance large expenditures on items like stoves and refrigerators. Again, this is important from a policy perspective, because the lack of access to credit represents an insurmountable barrier to entry into markets in which there are high up-front costs. The onus should therefore shift to the relevant development institutions to facilitate this access to finance for poor households. Finally, an objective of household energy policy must be to widen the range of choices which households are faced with in meeting their energy needs. This should enable poor households to satisfy their energy requirements, or at least a portion thereof, at a lower cost than is currently possible. In some cases, households are forced to use relatively expensive and inefficient fuels for certain end-uses, such as candles for lighting and batteries for radio and television. A wider range of choices should translate into lower energy expenditure and thereby release financial resources for other purposes, whether related to energy services or not.

2.4 Principles to guide the financing of energy investments

This section proposes a number of principles which may guide the financing of energy investments, and which constitute a set of assumptions which underlie the subsequent analyses.

2.4.1 Maintain overall macro-economic balance

Fundamental to energy policy is an assumption that economic policy will seek to maintain (or pursue) overall macro-economic balance: that is, government will avoid excessive deficit financing or money creation, and the balance of payments will be managed so as to prevent excessive deficits. In other words, economic policy, which will have redistribution as a high priority, must recognise the limitations on available resources and must essentially maintain government activity within its means. The importance of maintaining reasonable macro-economic balance lies in the dangers of excessive government spending, which would have to be financed either by increased borrowings or the creation of more money, or by a combination of the two. The former may impose enormous burdens on the fiscus in the future due to capital repayments and finance charges which often also entail outflows on the balance of payments, while the latter results directly in inflationary pressure. Beyond a certain point, these conditions can become self-reinforcing, resulting in a 'debt crisis' and/or hyper-inflation. In some respects, this principle presupposes that the economic variables are currently in balance but, as mentioned earlier, this is not the case. Nonetheless, the importance of maintaining control over government spending and expansion appears to be recognised by most political actors.

2.4.2 Energy and other services to be prioritised

Whilst EPRET's focus is, by definition, on the *energy* needs of households, it is important to stress that energy is only one of many services urgently requiring investment and development. The national priorities in coming years are many, and of great scale: including housing, education, health, and water and sanitation services. In many respects energy requirements are of lower priority than some of these and should not divert resources from areas of greater need.

Two perspectives are relevant here: firstly, account must be taken, at the micro level, of the preferences of end-users, and their priorities must inform the allocation of resources. This is more relevant to development at the project or programme level. The second perspective is at the macro level, where policy-making must attempt to allocate resources according to areas of greatest national need.

In some respects, there is a danger that the energy sector may attract a greater share of national resources than would theoretically be desirable, because it has strong institutions and can access resources more effectively than many other sectors. For instance, the water and sanitation sector does not have any national water utilities equivalent to Eskom, nor are there strong private sector corporations as in the petroleum industry. It is difficult to counter this potential bias towards the energy sector. One way is by ensuring that the resources within the energy sector are employed to the full, before any external allocations are made (such as from government budgets). As will be discussed, there are considerable amounts of finance available within the energy sector itself.

2.4.3 Financing and pricing arrangements to maintain financial viability of institutions

It is suggested that the point of departure in establishing financing arrangements and setting price levels should be that broad cost-reflectiveness and cost recovery are achieved. The experience of numerous utilities and institutions, especially in African and Latin American countries after independence, has been that price levels have been kept down by governments in order to make services affordable to the poor, or to appease their constituencies, to such an extent that utilities have become economically crippled. In the longer term, the inability of institutions to meet their revenue requirements from their own consumers has severely impaired their capacity to deliver services as mandated. Consequently, it is essential that service delivery in the energy sector pursue, as a starting point, the principles of cost reflectiveness and cost recovery.

The suggestion that cost reflectiveness should be the point of departure for financing and pricing policies does not imply that it is also where financing and pricing policies must stop; the use of grant finance or cross-subsidisation is not precluded. In fact, as will become apparent later, a crucial issue for policy-making in the financing and pricing arenas, is to 'get the prices *wrong*' while maintaining overall economic viability. More specifically, it is possible to design financing and pricing regimes in which individual consumer classes benefit by transfers from other classes through, for example, cross-subsidisation. Such departures from narrow cost-reflectiveness principles are acceptable, provided they can be adequately justified, in order, for example, to achieve redistributive transfers, whilst simultaneously not compromising overall financial viability.

2.5 A brief description of two household energy scenarios

This section briefly outlines two scenarios which describe the patterns of, and trends in, household energy use over the period to 2010. These scenarios are used as tools to assist in the analysis of the financial and economic impacts of policy options emanating from the EPRET sectoral studies.

2.5.1 *Business as usual scenario*

Under this scenario, current conditions in the household energy sector are projected into the future. Consequently, the main trend here will be that the current electrification programme proceeds with connection rates of about 250 000 per annum, before dropping off by the end of the decade to about 150 000. No substantial changes are envisaged in the current pricing arrangements, the structure and governance of the electricity supply industry or the financing of electrification. Under such a scenario, about two-thirds of households will have access to electricity by 2010.

Other energy subsectors are expected to see little change under this scenario, and the impact of policy efforts such as the Biomass Initiative will be limited. Likewise, the current problems associated with fuelwood scarcity will persist, as will the environmental and health hazards experienced by poor households: indoor air pollution, paraffin poisoning, and burns and fires from non-electric sources of energy. Relatively little attention will be devoted to improving access to energy services for poor households or small-scale enterprises in either urban or rural areas.

Essentially this scenario is characterised by a lethargy in household energy policy, with poor integration of demand and supply considerations, and a fairly narrow focus on increasing electricity supply rather than a providing the optimal mixture of energy sources for particular end-uses. Whilst in reality there will clearly be policy initiatives other than electrification, these are considered insignificant for the present analysis. Where such interventions are likely to be significant, they are accounted for in the integrated energy planning (IEP) scenario.

2.5.2 *Integrated energy planning scenario*

This scenario describes a set of household energy policies for the next decade and a half, on the assumption that the principles of IEP are applied and implemented. The scenario is informed by the three goals of sustainable development: economic efficiency, social equity and environmental quality. Of these three, the principal goal is to improve equity – by increasing the access of the urban and rural poor to cleaner, more convenient sources of energy at affordable prices.

The first principal feature of this scenario is the extent of the electrification programme, as well as the structural changes which are required to give effect to it. A primary goal will be to provide as many households as possible with *access* to electricity by about 2010. The percentage of the population which will be connected depends on a number of factors, such as household income levels, connection costs, the availability of finance, tariff levels, consumption levels, and availability of alternatives; for present purposes it is assumed that 85-90% of households will be electrified by 2010. This would entail an annual connection rate double that of the business-as-usual scenario. By the end of the next decade the connection rate would be sufficient to keep pace with the rate of new household formation.

The second feature of the IEP scenario is an explicit recognition that electricity may not be the optimal source of energy for all end-uses, and therefore energy policy will incorporate other supply and demand interventions to optimise the mix between energy sources and end-uses. Consequently, there will be a major thrust to replace conventional bituminous coal with low-smoke coal. The main motivation will be to reduce air pollution levels both indoors and outdoors; secondary goals will be to utilise some of the approximately 40 million tons of discard coal produced annually, and to increase the income-earning opportunities of poor people in small-scale manufacturing activities. This policy will aim to gradually eliminate household use of conventional coal, and to encourage its substitution firstly by low-smoke coal, and also by electricity, gas and possibly paraffin (as appropriate).

At the same time, the IEP scenario envisages an improved distribution network for gas and paraffin, especially in rural areas and urban townships. The aim will be to reduce the inefficiencies and unnecessarily high mark-ups currently found towards the end of the distribution chain. The aim would be to lower prices to consumers, to encourage oil companies and distributors to extend their networks into areas presently unserviced.

Firewood is likely to remain the major source of energy for cooking and heating in rural areas for many years. Policy will therefore aim to secure energy supplies for rural households, through a mixture of natural woodland management, social forestry and woodlot development, encouraging small-growers, and the use of commercial wastes. At the same time, fuelwood demand may be influenced through improvements in access to gas and paraffin supplies, as well as to electricity.

Under this scenario, demand-side management programmes will attempt to improve the efficiency of energy-use at household and macro levels. Firstly, energy-efficient structures will be encouraged, in both existing and newly-built housing stock. Secondly, specific interventions by electricity utilities will seek to improve the penetration of energy-efficient appliances. Thirdly, time-of-use tariffs will be implemented to encourage shifts in electricity use to off-peak periods. Finally, appliance-labelling programmes will be implemented to provide consumers with information about the efficiency of appliances.

This scenario involves building on existing initiatives of a wide range of actors in the energy sector, and implementing policies on both the demand and supply sides. Many structural changes are required, for example in the system of policy-making and regulation of the energy sector as a whole and its subsectors. These have been more fully described in the relevant EPRET papers; subsequent chapters of this paper describe their financial and economic implications.

CHAPTER THREE

The financing of household energy policies

This chapter assesses the financing implications of the main energy subsectors addressed in the Energy Policy Research and Training Project: including electrification, fuelwood provision, low-smoke coal development, a range of gas and paraffin interventions, and demand-side management strategies. As such, this chapter is essentially concerned with the integrated energy planning (IEP) scenario outlined in Chapter 2. Each of the major policy sectors is addressed separately. Where relevant, current financing arrangements are described, and proposals are made regarding potential additional sources of finance. In some cases, recommendations are made around the establishment or use of specific mechanisms or institutions to raise and allocate finance for particular policies.

3.1 The financing of electrification

This section has five main components: firstly, it presents a number of principles which, it is suggested, should guide the financing of electrification. Secondly, it describes the current situation in the electricity supply industry regarding financing sources and mechanisms. Thirdly, it identifies a number of key questions which define the current research agenda and, fourthly, makes several policy proposals in an attempt to answer these questions. Finally, it provides an indication of the amounts of finance which may be required for an illustrative national electrification scenario.

There are two main reasons for undertaking investment and financial planning in EPRET. Firstly, energy policy planning takes place in a situation where finite resources are available to meet needs which are, in effect, almost infinite; therefore investment planning assesses whether the resource demands are feasible given the overall resource constraints or ceiling. If not, then an iterative process will be necessary, so as to match the proposed supply and demand interventions with available resources. The availability of economic resources is only one (although critical) constraint on energy planning, along with others like political, environmental and social factors. Secondly, investment planning represents the final translation of the energy policy proposals into a common monetary unit. This allows for cost comparisons and cost/benefit analyses, both internal to the energy plan, and externally with alternative areas for investment/expenditure such as housing, health, and education.

While the term 'finance' has many dimensions, its meaning should not be too controversial. For present purposes it may be useful to highlight a distinction between *loan* and *grant* finance. The former generally involves a commitment by the borrower to repay, at some future date, the amount received; the loan may or may not carry interest. Grant finance generally does not include any commitment by the recipient to repay the original amount. This distinction is important for the discussion which follows. A related distinction occurs around *concessionary finance*, which generally entails the granting of a benefit to the borrower in relation to the terms under which finance is granted. Concessionary finance may range from a small discount in the interest rate, to a delay in the commencement of interest and capital repayments, to an unconditional grant. All sources of finance fall somewhere along the spectrum between market-related and grant finance.

In many respects the current discussion intersects with electricity pricing policy, another key focus of the EPRET project. Financing and pricing are closely interlinked, and the boundaries between the two are frequently crossed in this chapter.

3.1.1 General principles governing the financing of electrification

The financing of electrification, and other goods and services which are in or near the public domain, is inherently influenced by political and ideological views. This cannot be avoided but can lead to unnecessary confusion if the underlying principles are not spelt out. Consequently, this section attempts to present a number of fairly broad principles which should guide the financing aspects of the detailed policy formulation process. These might not be supported by all actors in the energy sector, but it is hoped that they have, at least, a measure of internal consistency.

(i) Financing and pricing policies should maintain the financial viability of electricity utilities

A financially viable electricity supply industry (ESI) is an essential precondition for a reliable and high-quality supply of electricity to households and commercial users in the long term. It is a fundamental point of departure of the present proposals that electricity utilities, such as Eskom and future electricity distributors, should manage their financial operations in such a way as to maintain their status as going concerns. This is necessary if utilities are to maintain their capacity to finance electrification of households well into the next century and, in the case of electricity generation, for Eskom to be able to finance further capacity expansion as and when required.

Eskom's sound financial track record might cast some doubts as to the primacy of this principle or, at least, as to its foregrounding in this discussion. This foregrounding is made, however, precisely to emphasise that the present financial viability of Eskom and some distributors should not be compromised if the ESI is to deliver on social and economic demands more effectively in the future. The experience of numerous electricity utilities in Africa, Latin America and Asia suggests overwhelmingly that financing and pricing policies must be financially sustainable in the long term. This principle should not be misinterpreted to mean, however, that utilities should operate exclusively according to narrowly-defined financial criteria, without consideration of the possibilities of, and necessity for, departures from conventional market principles. In fact, much of the present discussion is concerned with identifying ways of departing from these principles in a manner which is economically and financially sustainable in the long term.

(ii) Public finance is necessary where private funds are inadequate

Following on from the previous principle, the first choice of sources of financing for energy investments should be the direct users or beneficiaries themselves. This means that the first responsibility is for people to attempt to pay for energy goods and appliances themselves – from income, savings, or funds from family, friends, lenders, and so on. In other words, electricity utilities should seek, as a first step, to recover costs from their customers. However, it is patently clear that there are many reasons why this principle, in isolation, would result in an undesirable situation – where better-off people would obtain the services they desire, while the worse-off would never be able to access improved energy sources. The reasons are obvious enough not to have to be listed here, save to say that significantly improved equity of access to electricity will not be achieved without direct public intervention. The implication of this principle is that financing and pricing policies should, as far as possible, be structured according to people's existing abilities to pay and, where necessary, should ensure that mechanisms exist to provide access to the service for those whose inability to afford it by themselves would otherwise exclude them.

Essentially, this position accepts that cost recovery is the overall (though not exclusive) goal, but that where cost recovery is impossible interventions will be required to achieve the policy objectives (such as widening access to electricity).

This position is informed by an interpretation of the South African economy in future years which suggests that the public sector will be very stretched to meet demands for redistributive expenditure and that the onus should not be automatically placed on the state to meet all the needs of the poor from its own resources. Rather, the private sector (which includes not only households but also, for example, insurance companies) has significant resources which should be utilised before drawing upon state resources.

(iii) External subsidy finance to be applied first to reduce capital costs for all connections

External subsidy finance (from, for example, the state, or foreign and private donors) is likely to become available for electrification at various stages of the electrification programme. These inflows are not likely to be smooth, however, and are certain not to be sustained. This money could be allocated in many ways – to benefit existing consumers, to electrify as large a number of households as possible, or to benefit all households which have been and will be electrified under the programme. It is proposed here, as a matter of principle, that grant finance designated for electrification should be allocated to subsidise capital costs of *all* low-income households which have been electrified in recent years and those which will be electrified under the national programme. The reasons for establishing this principle are as follows:

- It is a more productive use of resources to apply them to *capital expenditure* (new connections) rather than to reduce *operating* costs for existing customers (lower tariffs). By their nature, operating discounts will be temporary and will produce limited lasting benefits, whereas new connections will increase the flow of benefits over a longer time. Moreover, allocation of subsidies to reduce operating costs would benefit only those who already have electricity. In other words, by allocating subsidies to capital costs, the barriers to entry posed by high connection costs can be removed or at least reduced, thereby widening access to a greater number of people.
- If grant finance is to be allocated to provide *more* people with access to electricity, then the most equitable approach is to spread its benefits as equally as possible among *all* households in the electrification programme, rather than those lucky enough to be participants in electrification projects at the particular time the finance becomes available. The mechanisms through which this can be achieved are discussed later.
- There may be a higher risk and cost if grant finance is applied to reduce operating costs: operating subsidies can become entrenched insofar as it becomes politically difficult to reduce or eliminate them, and they may have higher administrative costs over time.

This principle refers to the use of subsidy finance which may become available from external sources, that is, from groups other than domestic electricity consumers. The different case of *internal* cross-subsidies is discussed below.

(iv) Cross-subsidisation is important, as it can help achieve equity goals while maintaining overall cost recovery and financial viability

The use of cross-subsidies is important, as it can improve the affordability of electricity services to the poor through transfers from more wealthy to less wealthy consumers. If a balance is maintained, such that the resource base from which the subsidy is drawn is large enough not to be adversely affected by the additional imposed cost, then the system as a whole can be financially and politically sustainable.

Two kinds of cross-subsidisation are relevant here. Firstly, a straight line tariff (such as Eskom's S-tariff or the tariff proposed in the IEP scenario) contains an inherent cross-subsidy since, at low levels of consumption, the supply authority is under-recovering its fixed costs from consumers while, above the break-even point (about 350 kWh per month for the S1 tariff), consumers will effectively be paying a surplus. A full discussion of pricing policy is beyond the scope of this paper; nonetheless, it is suggested that cross-subsidisation within the domestic consumer base can be achieved so as to be progressive (that is, redistributive towards the poor), as well as being financially sustainable in the consumer base as a whole, provided the over- and under-recoveries balance each other over time. The second kind of cross-subsidy occurs at a different level: between consumer groups for which tariffs do not reflect differentials in marginal costs of supply. At present, this kind of cross-subsidisation occurs, for example, from consumers in the PWV area to consumers in the Cape or other areas far from the main generation base in the Eastern Transvaal, because domestic tariffs do not fully reflect geographical differences in transmission costs. Similarly, a national or regional domestic tariff would entail a cross-subsidy from consumers for whom marginal costs of supply are lower than the tariff, to those whose supply costs are equal to or above the tariff. As will become apparent later, this cross-subsidy can be a major source of finance for the ESI and for electrification.

(v) Considerable local sources of finance are available
South Africa differs from many developing countries in that it has much greater local resources in general and accumulated wealth and savings in particular (even though control thereof is highly concentrated and racially skewed). Furthermore, the investment requirements for household energy policies are generally much smaller than the investment requirements for integrated energy plans in other countries, which often involve expansion of generation capacity. These two factors combined mean that, unlike in other developing countries, much of the investment requirements for a national electrification programme can be met from local sources, at least in the short and medium terms. Only if investment levels and economic growth pick up dramatically in the coming decade might investment funds become scarce (and more expensive) locally, making it necessary to seek foreign funding for development investments. The extent of dependence on foreign funding to finance electrification is therefore not significant.

This point is underscored when the scale of investment required for household electrification is compared to the sums involved in other large-scale investments (either in South Africa in the past, or in other developing countries now). The comparison reveals that the capital requirements for electrification are similar to, or less than, the requirements for the construction of major power facilities, or for the investments in Sasol, Mossgas and the AEC – moreover, the social return from electrification is likely to far exceed the returns from some of these investments.

The South African energy sector is particularly fortunate compared to other local development and service sectors, and compared to many other developing countries, in that it has significant internal sources of revenue and savings which could, theoretically, be applied to new investment. In fact, some of the revenue in the energy sector is currently appropriated by various levels of government and transferred to other sectors: for example, the fuel levy on petroleum sales, which contributes about 10% of total government revenue in South Africa, and electricity surpluses in white local authorities, which are used to subsidise rates and taxes. It is suggested, therefore, that the revenue base of the electricity supply industry might be utilised more effectively to support national development goals, such as electrification. Possible measures will be addressed later.

3.1.2 Current financing arrangement for household electrification

Electrification expenditure can usually be financed from two sides: by the household being connected, and by the distributor doing the connecting. If the household is unable to organise finance itself, then the distributor generally has to raise finance. From the perspective of the household, there are several ways in which its connection to the grid can be financed at present:

1. If electricity is included in the construction of a house from the beginning, and the house construction is purchased with the assistance of a mortgage bond from a bank or building society, then the capital connection cost is included along with the rest of the cost price, and is also repaid over the lifetime of the mortgage (15 to 30 years). This option is available only to people who qualify for mortgage lending, which has historically been only the relatively wealthy. A stable and adequate income is generally the most important prerequisite for this kind of financing.

2. If a household has sufficient *cash* to pay for connection, a lump sum can be paid (say R2 000 or more, depending on the technology).

3. For the bulk of households unable to afford this amount of cash or to finance the connection through a mortgage or other loan (that is, options 1 and 2 are excluded), the only option is a tariff system under which the distributor initially finances the capital cost and recovers it, with interest, through the tariff, over about 15 years. The Eskom S1 tariff and the tariffs of a number of local authorities operate in this way. The effect is that households pay an additional six cents or so per kWh in respect of the original capital cost which was financed by the distributor (given various assumptions, such as average consumption of 350 kWh per month for 15 years, and a low real discount rate). Lower tariffs may apply to situations where a portion of the connection costs has been paid and, therefore, less has to be recovered through the tariff. The advantage of this arrangement, therefore, is that the entry barrier for households with little or no savings is removed or reduced; the disadvantage is that they pay higher tariffs than other customers whose capital costs have already been paid off (or financed through a housing bond or other loan): a potentially unpopular political situation.

This third option currently applies to almost all of the new connections being made in South Africa. A crucial prerequisite is therefore the ability of the distributor to raise the finance necessary to pay for the connection. The present structure of the EDI means that this onus rests either on Eskom or local authorities – which have very different financing capabilities.

Eskom

Eskom has a well developed financing capacity, with a treasury department rated as one of the top ten in the world in 1992. It has outstanding debts of about R27.6 billion, R9.2 billion of which is from foreign sources, and has consistently been able to raise money at a lower interest rate than the government. Its biggest bond, the Eskom 168 (E168) is a benchmark in South African capital markets, with approximately R13 billion having been raised through this bond. In addition to its borrowings through instruments such as its bonds, Eskom also seeks loans in capital markets and development finance institutions such as the Development Bank of Southern Africa (DBSA). Much of Eskom's past borrowing, and therefore its outstanding liabilities, was necessary to finance power station construction.

Eskom's expenditure on electrification is relatively small in comparison to generation capacity expansion. In 1992 actual capital expenditure on electrification was about R450 million, or about 12% of the total (R3.6 billion). Total capital expenditure was financed almost entirely from its cash flow from operations which, after finance charges, was just under R4 billion.

In May 1993 Eskom raised another R600 million through a different kind of borrowing agreement, the Electrification Participation Note (EPN, or simply the Electrification Bond). The EPN is an innovative financing mechanism which has potentially great significance for future financing of electrification – and of housing and other social investments. The EPN is a dedicated-purpose 15-year bond, raised specifically to finance electrification, carrying a split coupon (interest) rate, which is designed to increase over the lifetime of the bond. Eskom pays investors a return linked to actual sales made to newly-electrified customers (based on sales on the S1 tariff), subject to a guaranteed minimum. In essence, therefore, investors (mainly life assurance companies and pension funds) receive a return which is at a lower-than-market rate in the first few years, but which should increase over time, thus yielding a market-related return over the full lifetime of the bond. Long-term investors are prepared to invest in the bond according to their normal business criteria, because they are concerned not with the short-term returns but with average returns over the whole 15 years; these should be market-related. Moreover, they perceive risk to be sufficiently low, because they have a guaranteed minimum return (equivalent to nearly 12% in the first issue) and because Eskom is regarded as a low-risk borrower.

This kind of financing mechanism has several advantages. Firstly, because it still provides investors with a market-related return, it is, in principle, attractive to commercial investors and can therefore tap into the enormous amounts of savings invested by the institutional investors. Secondly, although prescribed asset requirements (PAR) were scrapped in 1989 after a long battle by the industry, it is possible new PARs will be introduced shortly, but with prescribed investments likely to be much smaller than before, and more focused on development needs. An instrument like the EPN would probably qualify as a prescribed investment and could therefore attract large amounts of funds. Thirdly, the successful issue of the EPN has set a precedent for institutional investors and is replicable in many other areas of social investment, not least of all housing. More specifically it offers possibilities for raising finance in a similar way for players in the energy sector other than Eskom. This option will be discussed later.

Local authority distributors

Local authorities have a range of possible sources of finance for electrification. Their capabilities vary enormously, however – from being fairly sophisticated in the large, white local authorities (WLAs), to being non-existent in politically and financially bankrupt black local authorities (BLAs). The actual number of connections made by LA distributors in 1992 is not known with as much accuracy as for Eskom, although it is thought to total about 40 000. The largest portion of these were made by the Durban Electricity Department (about 13 000), which has the second largest number of customers in the country (Eskom overtook it in 1992).

One source of finance for electrification capital expenditure by LAs, is their capital development funds (CDFs), which have been built up over the years from operating surpluses, and which lend money, within the LA, in respect of new development projects (usually with interest). These CDFs can be sizeable in the case of larger WLAs. LAs can also raise finance on capital markets through the issue of municipal bonds, although these do not generally have the same status and tradeability as, for example, Eskom bonds. Municipal bonds fell under the category of prescribed investments until 1989. Another source of finance utilised by local authorities is slightly lower cost finance from institutions such as the DBSA. In 1992 the Bank made significant financing commitments for electrification projects undertaken by both LAs and Eskom. Again, however, this applies only to WLAs – although even small municipalities have issued bonds. BLAs, on the other hand, have historically lacked the capacity or legitimacy to raise any finance for electrification.

The inability of LAs to raise sufficient finance is a key constraint on more rapid and widespread electrification at present, along with the central problem of their racial fragmentation and political illegitimacy. Thus, while Eskom is likely to succeed in meeting its share of electrification targets for the next few years (ranging from

160 000 to 200 000 per annum), LAs will almost certainly make little progress under the status quo. This issue will be taken up again below.

3.1.3 Key issues and problems regarding the financing of electrification

A number of issues and questions will be identified in this section, which essentially outlines the key research questions. Possible answers and policies will be offered in the next section.

(i) What is the most effective and equitable way of dealing with any subsidy finance which may become available?

Various propositions have been made so far on this issue. Firstly, that the ESI is well-resourced: through Eskom, WLAs, non-domestic consumer base, and so on. Secondly, that government will face huge demands for social spending, of which electrification will be only one; consequently, electrification should not be reliant upon state subsidies.

Nonetheless, it is important that the financing and tariff system should be able to *accommodate* any subsidy finance which may become available. It is probably a fair assumption that this money, from the fiscus and/or from foreign donors, will not come in a smooth flow. The question is, therefore, how to ensure that this money is used most effectively and in such a way as to benefit those who need it most. It would be unfair if certain households received a subsidy just because money was available at the particular time they were electrified, while those being electrified just before or just after the money was available lost out. It is therefore essential that financing arrangements and tariff structures are able to absorb whatever subsidy finance becomes available, so that the benefits of that finance are spread as evenly as possible over all intended beneficiaries. How can this be achieved? And what must be done to ensure that this money is not appropriated or swallowed up by bureaucracies or institutions with little positive impact?

(ii) Should electrification be cross-subsidised by other consumers?

This is a complex question, and can be further broken down. Cross-subsidisation for present purposes could be taken to apply either to the connection costs, or to the energy costs. Firstly, should there be *any* cross-subsidisation at all? If not, customers will have to pay for the full connection costs themselves (over 15 years through the tariff, unless they benefit from capital subsidies), and for the actual costs of energy consumed. Clearly, this is the most clean-cut option and is simplest to administer, but may exclude the poorest people. Secondly, if it is accepted that cross-subsidisation is necessary, then should subsidies come only from within the *domestic consumer* category? If so, the burden would fall most heavily on high-consumption households – would this be affordable?]Thirdly, if cross-subsidisation is necessary, could this come from *non-domestic consumers*? If so, how would the price increases affect them? They might be encouraged to replace electricity with other fuels (where technically possible), their competitiveness might be compromised (for example, the big exporting beneficiators). Conversely, higher electricity prices might encourage different directions in industrial development which may be more advantageous in the long term, such as less energy-intensive and more skills-intensive development paths. Finally, if a cross-subsidy is to be drawn from other consumers to subsidise electrification, how should that money be applied? It could be applied to subsidise the energy (or operating) costs of energy use by households (in which case it would be relatively open-ended), or the funds so raised could be re-allocated to the capital costs of new connections, possibly via a National Electrification Fund.

(iii) How to finance rural electrification (RE), and when?

The way Eskom and other distributors are currently approaching electrification, poorer and rural areas will be electrified only *after* all 'viable' (that is, financially viable) areas/homes have been connected. This way, rural electrification (RE) will happen towards the end of the programme (10-15 years), which means that the poor will once again be ignored in the meanwhile – and, maybe, if there are insufficient resources, ignored forever. How then can current financial arrangements ensure that RE succeeds? And can we avoid the prioritisation of urban/wealthier/higher-level consumers ahead of rural/poorer/lower-level consumers? In fact, *should* this timing be inverted? It seems that this is a clear conflict between efficiency and equity goals: it makes short-term economic sense to electrify better-off areas first and poorer ones later; but equity goals suggest that the poor should be electrified before, or at least at the same time as, the more 'viable' areas. How can this be handled? If electrification focuses on the less-economic areas earlier, the sustainability of the whole process might be jeopardised if the resultant financial burden becomes too great.

(iv) Should electrification draw upon current and/or past profits of the ESI?
It is generally held that electrification will come to a halt long before all households are connected (perhaps at around 60-70% of total households) *if* it is driven by financial goals only. Consequently, if more widespread electrification is to be achieved, there may be a need to draw on the reserves of the ESI. A question is whether electrification should be financed only out of *current* surpluses (that is, electrification must not cause Eskom and distributors to make a loss in any year) or whether *past* surpluses can be utilised (that is, supply authorities can utilise their/financial reserves).

This has implications for the risk rating which Eskom and LAs currently have and if, for example, their financial position deteriorated significantly they would be more hard-pressed to obtain finance for any major investments (new power stations, regional grids, DSM programmes, further electrification, etc). Moreover, if the situation deteriorated too much, the state would be obliged to step in to support them. Clearly, a degree of financial security must be maintained.

(v) If there is a capital subsidy, how to maintain the incentive to cut costs?
There is a danger, if capital connection costs receive subsidy support, that Eskom and other distributors would lose some incentive to cut connection costs through innovation and research. Already, with limited support for electrification research, significant savings have been made possible (for example, prepayment meters, ready boards, SWER), and these have been driven largely by the needs to bring down capital connection costs and reduce financial risk. Whatever subsidies are applied, in whatever form, it is essential that there still be an incentive to bring down costs (without sacrificing too much in terms of such things as quality and employment).

(vi) What roles for Eskom and local authorities in the short term?
As outlined earlier, LAs are unlikely to make significant progress with electrification in the short-term, which raises the question: do we wait until the electricity distribution industry (EDI) and local government have been restructured, before increasing the rate of electrification in these areas? The immensity of the country's social and development needs suggests that the answer must be in the negative.

The next question is therefore, how should electrification proceed in the meantime, so as to maximise its long-term benefits within the constraints of an imperfect EDI? Should WLAs be encouraged to electrify black areas, perhaps through Eskom's current incentive scheme? Should this incentive scheme be stepped up to make it more attractive? Or should Eskom continue to negotiate the take-over of areas with and without electricity – from BLAs, regional and homeland authorities – in the meantime? And if so, what must be done to ensure that Eskom's take-overs in the short term do not prejudice the long-term goal of a restructured distribution industry?

3.1.4 Policy proposals

This section will present some key proposals, corresponding to the questions posed in the previous section.

(i) Eskom's role to be increased until the EDI is restructured

It has already been argued that the electrification programme must be stepped up from its current levels, and that local authority distributors are not going to make the desired impact until the EDI is restructured. It is therefore suggested that Eskom increase its planned role in the electrification programme in the medium term. This will entail increasing its annual connection rate from the present (approximately) 160 000, and the total planned number of connections from the present plan of about 1.2 million houses by 1998 to more ambitious levels.

The exact rate of connection cannot be determined here, but a figure of ***at least*** 250 000 per annum should be feasible. The capital requirements for this would be in the region of R750 million per annum, which could be met entirely (or largely) from the proceeds of annual tranches of the Electrification Bond. The existing capacity of local distributors would be stretched to meet these targets, and may therefore need to be strengthened. This addition to their cost structures, however, should not be resisted too strongly – these are part of the very 'multiplier effects' which are supposed to arise from a large-scale electrification programme.

For Eskom to increase the extent of its involvement, it will have to continue to negotiate the take-over of supply areas from LAs and other authorities with legal supply rights. These negotiations should be done in an inclusive manner, so as to secure the commitment of all parties involved, from civics, to LAs, to the relevant national fora, and so on. Moreover, it must be clear that Eskom's take-over of these areas is an interim measure and will be subject to the future structure of the EDI which should emerge from negotiations in the National Electrification Forum and Local Government Negotiating Forum. It may be desirable, however, as an interim measure, for Eskom to take over the distribution functions of ***all*** supply authorities, pending the rationalisation and restructuring of the EDI along more efficient lines.

In this respect, it is important that any transfers of assets and liabilities to Eskom from LAs should not unfairly prejudice any party. More particularly, transfers, both under these interim arrangements and in the transition to a restructured EDI in the long term, should be done at a fair value which will act as a consistent basis for subsequent transfers to distributors in the future EDI.

Having said all this, existing local authorities must still be encouraged to increase their electrification efforts in the interim. In 1992 about 40 000 connections were made, with no major increases anticipated in the near future. Eskom's current incentive scheme (which generally means LAs get paid R400 per connection) should be maintained. In addition, political pressure on WLAs to play more proactive developmental roles in their functional urban regions, may facilitate electrification initiatives until non-racial municipalities are in place.

(ii) Maintain a balance between urban and rural electrification

It is likely that RE will entail a lower level of supply to households, with lower connection costs (although perhaps still higher than for urban areas). The minimum level of supply will probably be adequate for, at least, lighting, telecommunications and a few small appliances. On this basis, RE will impose less of a financial burden on distributors and households than if it were to take place on the same technological basis as in dense urban areas.

It is proposed that the electrification programme should aim to achieve a balance between urban and rural areas from the beginning. Urban areas may be more cost-effective to electrify, but any policy which waits until all urban areas are electrified will mean either that RE never happens, or takes place on an insignificant scale many years from now. The prime motivation for devoting resources to RE now is as follows:

- There is a political and redistributive imperative to address the material needs of the poorest households; electrification can play a key role in improving the quality of life of the rural poor and in facilitating more widespread rural development processes. In other words, it is politically and socially necessary, if the position of the poorest is to improve, that resources be devoted to RE from the beginning of the programme, rather than towards the end.

Taking this as the point of departure, several factors will help offset the greater financial burden on distributors of spreading new connections over both urban and rural areas:

- Firstly, RE can be a central part of rural development programmes and, if coupled to productive activities where appropriate, could increase other opportunities to increase consumption to levels which make RE more viable. Rural development programmes are likely to form part of a democratic government's development policies and will be implemented in the short and medium terms. Electrification should be a part of these programmes. Moreover, the process through which rural connections are made initially, and serviced thereafter, is one which could involve communities more directly. On the one hand, this should be a feature of development interventions, in which local people benefit from resources being transferred into the area while, on the other, it may also result in lower capital and operating costs through the use of local resources.
- Rural electrification can benefit considerably from research and development efforts, insofar as innovation and research will bring down connection and service costs. If RE has a sufficiently high priority immediately, a greater incentive will exist to realise these savings. The sooner these benefits accrue, the greater will be the total resource savings over time, since these benefits will also be realised in urban electrification projects. If RE were to take place on a large scale only in, say, ten years' time, the savings which might result from innovations at that stage would be lost in respect of all existing customers.
- Thirdly, assuming that RE will take place at some stage, then the risk factor associated with RE will be lower, if it occurs in parallel with urban electrification, than if RE were to take place largely on its own later. Obviously, in the short term the risks of urban electrification will be higher than if RE is not also taking place simultaneously. However, over time, risk levels may be lower on the whole, because of the diversification of risk across urban and rural areas at any one time.
- Finally, the case of rural farmworkers presents itself as a unique category of rural households, which may provide an important entry point into the broad area of rural electrification. Whilst over 70% of farmers outside of the homelands have access to the grid, less than 20% of their farmworkers enjoy the same benefit (Hofmeyr 1993); moreover, the large number of people in this situation (estimates vary from four to seven million people), means that a large portion of rural people could be electrified at a relatively low cost. The connection of farmworkers' dwellings to the grid where farmers already have such a connection will result in a more effective utilisation of those existing distribution systems.

The financing implications of prioritising RE earlier rather than later can, it is suggested, be accommodated within the financial arrangements proposed in this paper. The point being made here should not be misunderstood as meaning that RE must proceed at any cost, at maximum service levels equivalent to urban areas – it will in all cases, be necessary to consider alternative methods of delivering high quality energy supplies for high value applications, and to choose the best mix of supply options. The assessment must incorporate not only financial measures of the expected returns of potential electrification projects, but a more comprehensive assessment of the social costs and benefits resulting from electrification. If this is the case, RE can play an important role in improving the quality of life for poor rural inhabitants.

(iii) Establish a National Electrification Fund under the NELF

An Electrification Fund (EF) should be established under the auspices of NELF. Preliminary work in establishing the fund could be done by the presently constituted Finance and Tariffs working group, but the Fund might thereafter obtain its own management status within the Forum. The main objective of an EF would be to raise finance for electrification and to act as a conduit between financing sources and expenditure on electrification programmes. Within this objective are a number of ancillary functions which may be served by an EF:

1. With a reasonable capital base, say R500 million to R1 billion, the Fund would have the leverage to secure much larger amounts of finance from lenders. This amount could thus act as a *loan guarantee fund* for institutional investors, for whom the risk of default on their loans would then be sufficiently low to justify new investments.

2. An EF could raise finance for electrification in areas outside of Eskom's current supply areas – those areas currently falling within the boundaries of LAs and rural areas, which do not have the capacity to raise funds for electrification. This might take the form of bonds, whose redemption and returns are guaranteed by central government, in much the same way as Eskom provides a guarantee of a minimum return on its recently issued Electrification Bond.

3. An EF can be used to spread the benefits of any subsidy finance which may become available, equitably over time among newly electrified households, thus preventing a situation where grant finance benefits only those involved in projects at the particular time when finance becomes available. The mechanisms through which this can be done will be discussed in more detail shortly.

4. Significant economies could result from having a single fund, especially insofar as it could act as a channel for financing of electrification programmes, from both local and foreign funders. In other words, it could have a diversified set of funders, including foreign donors, which would reduce its dependence on any single funding source and, in turn, spread the risks for lenders or donors among a wider range of stakeholders. The risk attached to such a Fund could conceivably be lower than if finance was raised by a number of institutions, and so loan finance could be obtained on more favourable terms.

A possible structure for the Fund is depicted in Figure 3.1.

Several important principles should guide the establishment and operation of the EF. Firstly, its establishment would require an injection of seed finance, sufficient to finance its operations until it is self-sustaining, and to act as a basis for securing further investments by local and foreign investors. Possible sources for this initial financing include national government, parastatals such as the DBSA and IDC, private sector investors, Eskom, foreign governments seeking to invest in new infrastructure, foreign development donors, a one-off levy on income or electricity sales (possibly repayable) and a range of other possible sources. Secondly, the operating structure of such a fund should be lean, so as to reduce its offtake of development funds to a minimum. This is largely dependent upon the scope of its functions, but it is suggested here that it should not be involved in the spending of funds raised. This should remain the responsibility of local government, community organisations and development agents. Thirdly, the EF should be accountable to NELF for as long as the Forum remains in place, and should conduct its affairs

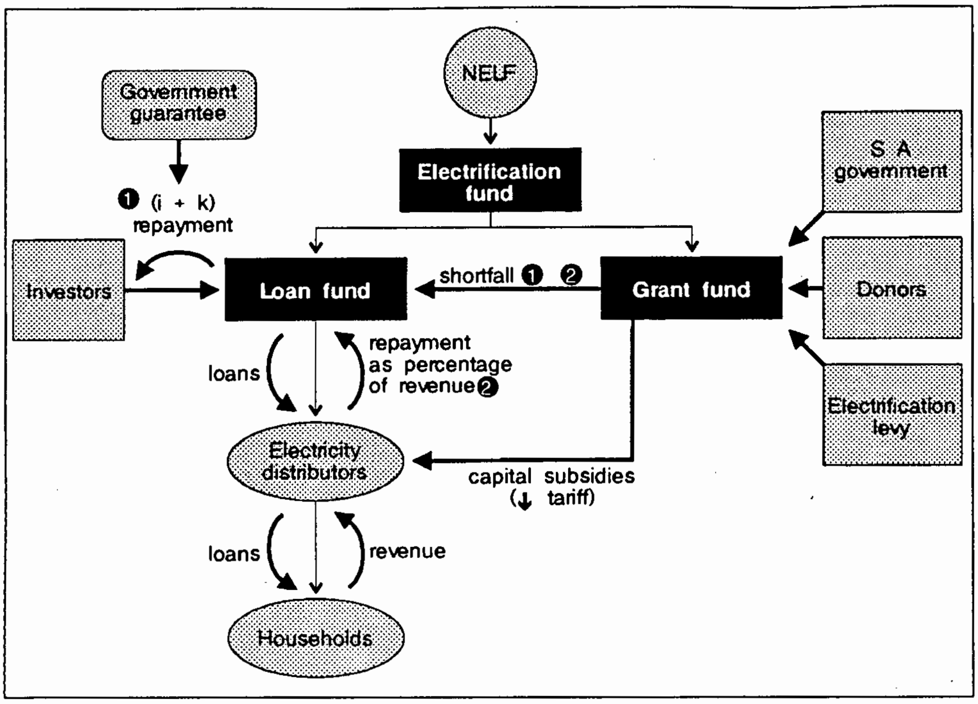

FIGURE 3.1 Proposed structure and operation of an Electrification Fund

in a public manner. Subservient to this, its accounting procedures should be subject to an independent annual audit – especially important in view of the large amounts of money passing through its books. Once transitional government arrangements are in place, they may subsume the functions of NELF, in which case it may be better for the Fund to be accountable to relevant government ministers.

In order for such a proposal to be practicable, it may be best for Eskom's Treasury Department to act as the agent for the EF. Eskom Treasury is a highly-sophisticated entity within the corporation, has considerable experience and expertise in raising and managing large amounts of finance, and would therefore further reduce the risk attached to the operations of an EF. In the longer term an EF might evolve its own capacity, more independently of Eskom. In either case, the management of the Fund would be accountable to NELF, and subject to whatever regulatory frameworks will be established in the ESI.

(iv) Subsidy finance to be channelled through the Electrification Fund

As noted earlier, it is probable that at some stage, subsidy finance will become available for electrification, either from the state or from donors. There are many ways of allocating this finance. One possibility is that money will be channelled through a housing/infrastructure development programme, as part of a capital subsidy covering all or some of the costs of serviced sites, roads, housing structures and electrification. This kind of programme depends upon the mixture of supply constraints: the capacity of delivery agents (such as builders and materials suppliers), as well as demands from communities, development agents and individuals. In some respects, such a model of delivery would be demand-driven, with funds being allocated to projects which qualify for subsidisation. While this makes the allocation process relatively simple, it also means that people will not benefit unless they are the subjects of development initiatives. Inevitably, funds will flow to communities which are better organised, have access to and can negotiate with local authority developers and private developers. The very poor are thus unlikely to benefit greatly from this kind of intervention approach.

A second alternative would be to channel all subsidy finance which is designated for electrification, through the EF. From here, there would again be various options. The EF could allocate finance to development projects on a demand-driven basis, that is, project by project. This amounts to the same thing as the route described in the previous paragraph – and suffers from the same problem of not being equitable across communities or over time. Alternatively, subsidy funds could be applied to the capital amounts outstanding in respect of the connection costs which were financed originally by distributors. Distributors would receive lump sums in proportion to the number of new connections they have made since the beginning of the electrification programme (say, January 1992). Under present tariff structures, these would be all S-tariff (and equivalent) customers. The benefit of this grant finance would then be passed onto all those customers, in the form of a reduced tariff. In effect, that portion of the tariff which represents the repayment of capital would then be reduced. This would also save finance charges on that portion of the outstanding loan. This option has the advantage of spreading the benefits of subsidy finance equally amongst all existing electricity consumers, and of not favouring some projects over others. However, it suffers from the major disadvantage of benefiting only existing customers, and does nothing to increase the number of households connected in the future.

A third option is for subsidy finance to be utilised by the EF in such a manner as to pass benefits on to all low-income households which are already, or will be, connected under the electrification programme. This might work in the following way: Firstly, a capital base would be established, beginning with grant finance from the state, and supplemented by other sources, such as foreign and local donors. A core amount of finance, of say R500 million to R1 billion, would be sufficient, acting as seed finance, to attract much larger amounts over time. The EF might operate two accounts: a Loan Fund and a Grant Fund. The core grant, or seed finance, would go into the Grant Fund. Loan finance would go into the Loan Fund, which would have to be adequate at all times to meet obligations for repayment of loans and interest. In order to reduce risk further, the state should guarantee the obligations of the EF – effectively ensuring that the Loan Fund will meet its commitments.

Loan finance

With a guaranteed amount of grant finance to act as security or collateral for other financiers, the EF could access large amounts of investment capital from institutional investors, through mechanisms such as the Electrification Bond. Such bonds would provide investors with an increasing rate of return over the lifetime of the bond, linked to the actual revenue derived from consumption. In addition, they would carry a minimum rate of return to investors, say 60-80% of the prevailing market returns (as represented by, for example, the yield on the Eskom 168). This would currently amount to about 9-12% per annum. These bonds should be of a long-term nature, say 15 to 25 years, since the return from electricity consumption is likely to be highest in later years. Repayment of bonds at term, and of interest every year, would be met from the following sources, in order of preference:

- From a portion of revenue derived from sales to newly connected customers (calculated as a percentage of revenue). Currently this would be a percentage of revenue from all S-tariff (or LA equivalent) customers. This would require that all distributors submit returns to the EF, containing the total revenue derived from all new customers, and that they transfer funds to the EF accordingly (effectively as repayment of capital originally lent by the EF).

- If these transfers are insufficient to meet the agreed guaranteed rate of return, then the EF would make up the shortfall from its capital base and from income generated from this base in the meantime (via the Grant Fund). In practice, it is likely that, in the short term, actual returns would be lower than the guaranteed rate, so that the Grant Fund would intervene.

- If the financial base of the EF becomes threatened by having to pay in significant amounts, then the state would, in terms of its final guarantee, ensure that the Fund is able to meet its commitments to lenders.

With this kind of arrangement, it is likely that the EF could raise significant amounts of investment finance from institutional investors.

Grant finance
There would be three main applications for subsidy finance in the Grant Fund. Firstly, it would be used to make up any shortfalls between actual returns from the distribution of electricity to new customers and the guaranteed return payable to investors. If actual returns are very low, then grant finance would also be utilised to repay a portion of the capital amount, not just interest. This would mean, effectively, that low-level consumers would be subsidised from this fund.

Secondly, if the Grant Fund has sufficient resources available to meet any obligations for shortfalls in the Loan Fund, both in current and future years (as would be the case, for example, if the fiscus provides support to a RE programme), then those sources of finance should be utilised to increase the number of households with access to electricity. This would be achieved by allocating grant finance to reduce the connection costs where these are high and where utilities would be unlikely to recover those costs from their consumers. In particular, this might entail a transfer from the Fund to supply utilities in respect of the excess of connection costs over the relevant 'cost-of-connection' parameter, which would be financed by the utility and recovered through the tariff over time. For instance, if the cost-of-connection parameters are set at, say, R3 000 per connection in urban areas and R5 000 in rural areas, then any excesses of connection costs over these levels could be financed by a transfer from the Grant Fund. Thus, if connection costs for a particular rural electrification project average, say, R7 000, then the utility would be expected to finance only up to the parameter of R5 000, with the balance coming from the Grant Fund (or, for example, reduced through contributions of labour by the community).

Thirdly, in the less probable event that the Fund still has additional grant finance available, after having fulfilled its obligations in respect of the above two areas, then those additional sources of finance could be applied to reduce the outstanding loan commitments of poor, newly connected households. Thus the Grant Fund would have to assess whether its resources were sufficient to make up any shortfalls which may arise on current and future loan repayments from the Loan Fund, together with capital subsidies for planned connections which cost in excess of established parameters. If there were additional subsidy funds available, or there was reasonable assurance that these would be received in the future, then those funds could be applied to reduce capital loans outstanding in respect of newly electrified customers. These funds would be applied to reduce the outstanding capital commitments of distributors, who would pass on the benefits to customers in the form of pro-rata reduction in tariffs. The national regulator (and, until then, NELF), would have to monitor this. Moreover, it would be necessary in the financial planning of the Fund's activities and in allocating funds to spread this subsidy finance over the period of the electrification programme so that its benefits accrue equally over time. Clearly, this financial planning process would be iterative, and would be closely tied with the electrification planning process.

The effect of this kind of arrangement is, therefore, that grant finance would be utilised to subsidise those who need it most – those who consume the least amount of electricity, and those for whom, in the long term, electrification will always be a sub-commercial proposition – in particular, the rural poor.

The nature of the EF's operation as suggested here is that it would be able to adopt a longer-term view of the financing requirements of a national electrification programme, and, moreover, would be able to build up its capital base from investment income and by securing further funds in the meantime. Inherent in these proposals is an attempt to minimise the actual and perceived risk to investors, lenders and supply authorities, by spreading the risk widely and fairly.

Obviously, clear principles would be needed to guide the operation of an EF. One of these is that the Fund's management and operation should be relatively lean and should not consume an unreasonable portion of the funds it manages. Also, provision should be made for the eventuality that the Fund is dissolved for whatever reason. However, given that electrification is unlikely to drop below a rate of 200 000 dwellings per annum, even if only to keep up with the rate of new household formation, it is possible that the Fund would have a long lifespan.

To summarise, the main advantages of channelling grant and loan finance through the EF in this way are, firstly, that leverage effects can be maximised by centralising funds into a single pool. In other words, this pool of funds can be used to generate more funds. Secondly, the Fund could ensure the optimum use of both grant and loan finance. Thirdly, the benefits of any grant finance which becomes available can be spread as equitably as possible among low-income consumers across the country and over time. Finally, this method of allocating subsidy finance will minimise fluctuations and distortions in prices, unlike a situation in which tariffs were reduced or increased according to the amount of subsidy finance which was available in any particular year.

(v) Cross-subsidisation of new domestic consumers

While cross-subsidisation is usually considered to be an issue in pricing policy, it is also closely related to financing considerations. As noted earlier, there are two kinds of cross-subsidy. The first relates to the inherent cross-subsidy from large consumers to small consumers which results from a flat-rate tariff. This issue is not being debated here. The second kind of cross-subsidy is highly relevant as a potential source of finance: the cross-subsidy from consumers whose marginal costs of supply are below the tariff, which will be particularly important with a *national or regional* tariff. The effect of this source of finance is described in more detail in Chapter Five, although it is clear that a national tariff in the region of 20 c/kWh would generate a considerable amount of additional revenue from high-income consumers: up to about R1 billion per annum. Clearly, there are many political issues involved with such a redistributive mechanism, and much depends on progress with the restructuring of the ESI. In any event, the impacts on high-income domestic consumers cannot be ignored. In practice, it is unlikely that a transition to national tariffs will take place overnight, so this source of revenue is more likely to be phased in over a period of a few years. The effect of phasing this income source into a national revenue pool is considered in more detail in Chapter Five. Even with a phase-in period, this presents itself as an important source of finance for electrification.

(vi) Electrification levy to finance electrification

Another important source of potential finance for the electrification programme is a small levy on electricity sales, based on units generated or transmitted. A levy based on total units generated and available for distribution, which (for Eskom) amounted to 138 126 GWh in 1992, will spread the burden of financing the electrification programme more widely. If a levy is imposed on generation at a level equivalent to a 4% price increase, an additional R500m would be raised annually. This, in turn, would allow the national domestic tariff, which is seen as an important source of revenue to finance the programme, to be lower – with all the social benefits this entails.

If such a levy is imposed, then it is proposed that the revenue generated be applied to provide more people with access to electricity, by transferring these funds directly to the EF. One question revolves around the consumer classes on which the levy should be imposed. In principle, it would be preferable to apply it in a simple and uniform manner, to all electricity consumers: domestic and non-domestic. This would avoid introducing any distortions between relative factor prices within the electricity sector. An objection might be raised by wealthier domestic consumers on the basis that they are paying two additional taxes or cross-subsidies: one based on a higher national tariff, another through this levy. However, this argument is countered by the fact that the domestic tariff can be lowered considerably because of the revenue generated by the electrification levy, and that it is administratively and theoretically preferable to introduce a more neutral, simpler levy on all consumers.

The levy could be imposed as a tax on all units of electricity generated, which would have to be paid directly to the Fund on a regular basis by generation authorities, including LAs. Clearly it would be in the short-term financial interests of such authorities to pass on cost increases to their customers. However, there may be cases where the utilities wish to protect their customers from price increases, in which case they could negotiate terms with customers. This may be especially relevant for large customers such as Alusaf, which have established long-term contractual agreements with Eskom. The point is that by imposing the levy on generators, based on their output, there would still be sufficient flexibility to allow for special agreements to be made.

A crucial concern with the imposition of such a levy, and the inevitable resultant price increases, relates to the impact of higher electricity prices on industry, mining and commercial users. Clearly it is undesirable for domestic electrification to undermine the international competitiveness of major exporters, or the economic viability of marginal consumers (such as mines). Although no detailed analysis of the price elasticities of electricity consumers has yet been done in South Africa, there does appear to be some prima facie evidence that an increase in electricity prices stemming from such a levy may be less undesirable than conventional wisdom suggests. Firstly, the real price of electricity has declined, and will continue to do so for as long as the price compact is extended. A 4% levy would therefore only offset the effect of the price compact, so that prices would remain constant in real terms. Secondly, while historically low electricity prices are a major comparative advantage in South Africa, they may result in an industrial development path which is undesirable in the long term: most developed countries have grown in the opposite direction, that is, away from energy-intensive manufacturing to higher value-added sectors. Thirdly, higher electricity prices may act as an incentive for greater efficiency – both of which have been prominent features in the economies of many developed countries.

In addition to these economic arguments, it is also possible to make ethical or political arguments around the need for mining and other commercial consumers to subsidise the electrification of households, most of which have suffered through apartheid.

(vii) Electrification within an economically viable ESI

International experience with electricity utilities suggests that performance, both with regard to existing customers, and to new connections, is related to the economic and financial viability of players within the ESI. This suggests that Eskom and local distributors should seek to maintain their financial security by following principles of cost-reflectiveness. Any departures from this principle (for example on the grounds of equity) should be rigorously justified, and should not compromise the long-term stability of the entity.

This principle does not preclude the use of surpluses accumulated in the past. It is therefore proposed that, as a matter of principle, Eskom and LA distributors be encouraged in the short term to utilise accumulated surpluses for investment in capital infrastructure, while not jeopardising their financial security by reducing their resource bases and increasing their risk exposures excessively. In Eskom's case, this will hinder its progress in reducing its debt:equity ratio to its long-term target of 1:1, although, over time, the electrification programme should yield a positive net present value. It should still be possible to reduce Eskom's debt levels, in order to reduce its exposure to high interest rates, for example, particularly through tight financial management and gains from demand-side management.

(viii) Maintain incentives to reduce capital connection costs

The kind of financing arrangements proposed here will maintain the incentive for Eskom and other distributors to keep reducing connection costs through further innovation and R&D. With the utilisation of capital loan finance through the EF, distributors will improve their financial status if they can keep connection costs as low as possible. Even if subsidy finance is available through the Grant Fund of the EF, it will not be used simply to meet the full capital costs of new connections, but will instead be spread over past and future low-income customers through the Fund. Consequently, distributors will still carry some of the risk associated with the connection process, and will therefore have an incentive to keep cutting costs. This would not have been the case, for example, if subsidy finance was available and was allocated directly to cover the full costs of connections – such an arrangement, in fact, could result in profiteering, a feature of subsidised development projects especially where these involve developers from the private sector who have little or no accountability to intended beneficiaries.

3.2 The financing of fuelwood policies

The fuelwood sector is a complex one from a financing perspective, for several reasons. Firstly, policies which affect the availability of fuelwood are often integral parts of broader development interventions which cannot easily be separated into their energy and other components. This means that financial implications of the fuelwood components of these policies are not easily isolated from the other components. Secondly, this is further complicated by the fact that measuring financial flows in the fuelwood sector is very difficult, even where fuelwood markets exist. Similarly, weaknesses in accounting systems and the difficulty of accounting for fuelwood-related programmes in the first place, make it difficult to accurately cost policy options. Thirdly, functional responsibility for fuelwood falls between many authorities and institutions, at all levels of government, further complicating administrative arrangements related to the management of budgets. Finally, there is considerable uncertainty regarding the numbers of households in rural areas, their demographics, income flows, energy consumption and expenditure patterns, as well as the wood resources available to them. This uncertainty is further complicated by regional and seasonal variations in many of these patterns.

Consequently, there is a considerably wider margin of error in estimates of the financing requirements of fuelwood policies than for policies in the electricity and other sectors. Nonetheless, the estimates which can be made are useful insofar as they can be compared with those from other energy subsectors. This section provides a rough assessment of the financing implications of the main policy proposals in the fuelwood sector.

3.2.1 Current financing arrangements

The current financing arrangements in the fuelwood sector depend mainly upon the type of wood resource insofar as ownership and access are concerned. While some woodlots are managed as commercial enterprises and fuelwood products are sold to consumers, this situation applies only in a small percentage of cases. The overwhelming bulk of wood currently consumed by households is collected from natural woodlands at no cash cost. Thus there are no explicit financing arrangements to speak of. Of course there are *social* costs associated with these arrangements – in, for example, the labour time devoted by women to wood-collection.

In most cases where fuelwood has been commercialised, the market for wood is established only at the retail or distribution stage. In other words, wood merchants generally still collect wood from areas with a surplus and transport it to areas of higher demand. This means that investments in expanding wood-supply are small and that the more significant financial requirements occur in respect of the collection and transport of wood.

Large amounts are invested in social forestry and agroforestry projects, especially by independently funded non-governmental organisations (NGOs). Again, it is difficult to provide financial estimates of the cost of fuelwood generated in this way, because of poor record-keeping, the overlap between energy and other products, and the problems of valuing many of these benefits. Nonetheless, it is apparent that the costs of extension and support in agroforestry projects can be very high. Generally, these costs are borne by the NGOs and their funders and are not passed on to beneficiaries of those programmes, who would be unable to afford them.

Social forestry and other fuelwood intervention policies often carry high initial project implementation costs, but their aim of empowering local people to sustainably manage their own wood supplies, if successful, removes the need for long-term financial support.

3.2.2 Financing requirements of fuelwood policies

Since fuelwood is the most widely accessible fuel for poor rural households, and because it is generally available for little or no cash outlay, the potential for principles of cost recovery to apply to fuelwood financing arrangements is much more limited than in other supply sectors such as electricity and hydrocarbon fuels. This does not mean, however, that policy interventions are not justified or that they will not be sustained. On the contrary, the costs of *not* intervening to secure fuelwood resources in rural areas are high enough to warrant such intervention. These costs are environmental, social and political: degradation of fuelwood resources, increased amounts of time spent by women and children in the collection of wood, and the additional poverty imposed on poor rural households facing resource scarcities. The political implications of such a scenario for a government with a strong rural constituency are serious.

In some respects, therefore, expenditure on fuelwood security may be seen as a precautionary investment in the rural environment, while it is also an investment in the basic needs of the rural poor and an attempt to reduce poverty levels. Moreover, a number of the potential interventions have beneficial impacts beyond mere increase in wood-supply, and can contribute to the development of rural areas as a whole. Their financing implications should be seen in this light.

A number of policies have been proposed in relation to the fuelwood and rural sectors:

- management of natural woodland;
- social forestry programmes;
- woodlots and plantations;
- promotion of commercial small-growers; and
- transport of wood from areas with surpluses.

Unless otherwise stated, all the estimates and data in this section are drawn from Gandar (1993).

Management of natural woodland

As noted earlier, natural woodland currently supplies the bulk of wood used by households, and this is expected to continue into the future. Consequently, policies to manage existing resources so that their capacities can be sustained or even enhanced will draw upon and enforce traditional land- and resource-management practices of tribal and local authorities. These practices include restricting of access to heavily depleted areas until they have regenerated, and removing undergrowth which restricts the growth of trees.

Policies which aim to strengthen these resource-management practices will utilise existing networks of rural development NGOs and extension workers from various levels of government. In most cases, these services would form part of multi-faceted development projects and programmes, and so the financing requirements related specifically to the *energy* aspects would probably be relatively small.

Social forestry programmes

The bulk of the *additional* production of firewood is likely to come from social forestry, which involves the dissemination of trees for planting by individuals and communities. Trees are planted not only for fuelwood, but also for use in windbreaks, homestead boundaries, community-based and household-based woodlots, and agroforestry projects – fuelwood is just one of many products in social forestry. This is a typical case in which the allocation of financial requirements between energy and other developmental institutions or budgets becomes difficult. The figures below are order-of-magnitude estimates only, and should be treated as such.

Assuming that social forestry is to yield 400 000-600 000 tons of firewood per year, then a network comprising roughly 4 000 small nurseries may be required, each producing 5 000-10 000 plants per year. At an estimated establishment cost of about R17 000 per nursery, this network might cost about R68 million to establish. In addition, start-up costs of about R15 million are anticipated. In subsequent years, recurrent costs would be lower, around R40 million. To place this amount of fuelwood in context, current sustainable supply for the whole country is estimated at about six million tons per annum, so that social forestry might aim to increase supply by 7-10%. These amounts should be financed jointly by the energy, forestry and agriculture departments, as well as by any rural development institutions or departments which may be established in government.

Woodlots and plantations

If the target in the woodlot and plantation sector is to supply about 900 000 tons of wood, of which about 370 000 tons will be used for firewood and the balance for poles and timber, then about 1 500 woodlots of an average of 60 hectares each may be required. Working on a fairly modest cost of establishment and maintenance to first crop of almost R2 900 per hectare, the total establishment cost of this network would be in the region of R260 million. After the first crop most of the recurrent costs would be met by revenue from wood sales. Clearly this sector would supply fuelwood to that market segment which is already commercialised.

Promotion of commercial small-growers

The large forestry companies currently operate small-grower schemes whereby they finance the establishment and maintenance costs of small plantations for independent farmers, which costs are repaid from the proceeds of the first crop. Additional costs (such as for fencing) are borne by the growers themselves. After the first crop, the small farmers should be able to manage their operations relatively independently.

With a target under the IEP scenario of 60 000 hectares of additional afforestation under these schemes, the total establishment costs which would be financed by the large forestry companies would be about R81 million. Extension and management costs, also borne by them, would be about R75 million for the first rotation period (roughly seven years), thus totalling about R156 million for set-up and maintenance. It is expected that this would produce firewood (as a by-product of the main timber produce) totalling about 60 000 tons per annum over the first rotation, increasing subsequently to perhaps 180 000 tons.

Transport of firewood from surplus to deficit areas
This policy proposal entails additional support for informal sector operators engaged in the transport and distribution of fuelwood from areas with sufficient accessible supplies, to areas where demand is higher. Such support would not be very intensive and would involve assistance from government departments to small enterprises in gaining access to credit, vehicles and so on. It is estimated that about 200 000 tons of additional firewood could be made available to households (some of them urban) in this manner.

3.3 The financing of low-smoke coal development

An important part of an integrated energy plan for South African households is the development of low-smoke coals, with a view to replacing conventional bituminous coals. This is particularly necessary in the light of the high levels of pollution which result from household coal combustion, with adverse effects on the health of millions of people who rely on coal for cooking and heating.

The prime motivation for the development of low-smoke coal (LSC), is therefore to alleviate the negative environmental and health impacts of coal combustion. LSC has not yet been produced in South Africa on a commercial basis – at least not on a large scale – and various prototypes are still in their development phases. It is therefore difficult to make detailed proposals about the financing of LSC, since the available cost estimates are tentative and likely to change considerably. Consequently, this section aims to describe the financial aspects of the three main types of LSC being developed in South Africa, and outlines proposals for future financing of LSC.

3.3.1 Current financing arrangements

There are three kinds of LSC which are the subject of this paper, with different technical properties, cost structures, and institutional characteristics (described in more detail in McGregor 1993). The financing arrangements applicable to the three products are described below.

(i) Enertek reconstituted coal briquettes
This is produced by binding coal discards with cement to form briquettes, in the ratio of 100 kg of coal to 15 kg of cement and 21 kg of water (Tait 1993). The cement acts as a binding agent and reduces the amount of particulates emitted upon combustion. Many households manufacture their own briquettes in this manner, although Enertek has attempted to optimise the product's performance through testing and further development. For example, the addition of a small amount of lime to the product may reduce sulphur emissions (although at a fairly significant cost). The three main components of the fuel's cost are for coal discards from mining houses, cement, and labour. Distribution costs must also be considered, and will depend mainly on the distance from the point of production to the point of sale.

No detailed costings have yet been undertaken for this fuel. Enertek's preliminary estimates suggest that production costs will be higher than the *wholesale costs* of conventional coal. However, it is entirely feasible that this product could be cheaper than *retail* coal. There are two main processes involved in manufacturing this kind of fuel. The first uses equipment similar to that used for brick-making, while the second is more labour-intensive, using large slabs. Some illustrative (and preliminary) cost estimates are shown in Table 1. By comparison, conventional coal prices for households in the PWV are in the region of R50 per ton at the wholesale purchase level (that is, ex-mine), and in a wide range from R160 to R320 per ton at the retail level (Palmer Development Group 1993: 26, 61).

	Brick-making equipment (4 tons/day)	Slab casting (2 tons/day)
Capital costs	3 300	2 000
Coal discards (R10/ton)	7	7
Cement (R285/ton)	31	31
Labour (6 x R30/day)	45	90
Depreciation (3 years)	1	2
Production cost (R/ton)	84	130

TABLE 3.1 Preliminary cost estimates for Enertek low-smoke coals (Rands 1993)

Of the cost components, cement prices are essentially fixed. While the quantity of cement used could be reduced, this would decrease the product's technical performance and therefore its acceptability. The other two main cost components are, however, considerably more variable. Discard coal is not traded at present and it is therefore necessary to impute a shadow price at which it might be purchased. There is scope for arguing that mining houses should not profit unduly from its sale: it is presently regarded as a waste product, with, if anything, a negative value because of the costs of disposing of it safely. It may therefore be possible to negotiate favourable terms for the use of discards suitable for LSCs.

Labour costs also vary. Both processes are fairly labour-intensive and are suitable for decentralised production, possibly at a community or cooperative level. This would have the important advantage of providing local people with income-earning opportunities and retaining expenditure flows within communities themselves. However, a disadvantage is that product quality may vary more widely and could deteriorate to the point where the product is no longer acceptable to users. This suggests that, if this option is to be followed, extension support may be required to ensure that small-scale manufacturers conform to product specifications within a reasonable range. The expertise which has been accumulated by the CSIR Enertek personnel responsible for this product's development is a valuable resource in this regard and could be utilised for training and extension work.

The preliminary costings shown in the table above suggest that this type of LSC may have an important role to play. Some financing options will be explored below.

(ii) Wits/UCP devolatilised coal

The two main ingredients in this process are waste coal (of a larger size than in the Enertek process) and waste heat. The discard coal is exposed to temperatures of 500° to 600°C for about two hours, to drive off, under controlled conditions, the harmful volatile compounds emitted during normal combustion.

The main cost components of the process are the discard coal and the heat, and the product will be economically viable only if both of these are by-products or waste products. Again, no detailed costing exercises have been performed, but it appears that this kind of LSC can be produced at a cost which will make it competitive with normal coal. This is because waste heat is utilised from UCP's industrial char production process, while suitable discard coal can be accessed at a low price (possibly around R8/ton) from mining houses. Production at a price which will not require any external subsidy finance may therefore be possible.

(iii) 'Wundafuel' solid fuel blocks

A private company based in Lesotho, Ecofuel (Lesotho) (Pty) Ltd, recently began to produce and market a solid fuel which also uses waste coal bound into small coal briquettes. The product, 'Wundafuel', is marketed commercially as a smokeless alternative to gas and paraffin, although it is technically a closer substitute for coal and wood. The DMEA has recently incorporated this product into its research support programme, which originally included only the Enertek and Wits/UCP fuels described above.

From a narrow cost perspective, this fuel will be less affordable for poor households than conventional coal, since it retails at a far higher price. According to the manufacturer 'Wundafuel' currently retails at R1.00 to R1.20 per kg, with output levels at approximately 120-150 tons per month (Roux 1993). With improved packaging, and if economies of scale can be achieved through expansion into a number of plants around the country, the manufacturer estimates a cost reduction to about R0.50 per kg, equivalent to R500 per ton (conventional coal retails at about R160-R320 per ton). Nonetheless, the product offers several advantages over conventional coal, such as its lower smoke emissions, its ability to light within a few minutes, and the fact that it can burn on the ground (like wood) and therefore does not require an appliance to be used. If consumers place a high value on these advantages the product may begin to replace normal coal at prevailing price levels. However, it is more probable that it will compete with more expensive fuels such as paraffin and gas, currently the main target market segments of 'Wundafuel'.

3.3.2 Policy proposals

It would be premature to make detailed policy proposals regarding the pricing and financing arrangements required to promote the use of low-smoke fuels in households which currently use coal. Further technical, economic and social research is required before financing and pricing mechanisms can be designed. Nonetheless, various financing policy proposals, at the level of principle, are presented below.

(i) Intervention is essential to mitigate economic costs imposed by coal usage

Research into household use of coal suggests that the resultant pollution causes significant health problems for the millions of people who are exposed on a long-term basis. These health effects carry major economic costs, such as the direct expenditure on health care services by affected households and the state, and loss of time for productive activity due to illness and absence from work or informal income-earning activities. Other indirect costs imposed by pollution include lower quality of life for inhabitants of polluted environments, as well as the contribution to global and regional environmental problems such as global warming and acid rain. While these links may be less direct, it is clear that, on the whole, household coal combustion carries huge costs, many of which are borne either by households themselves, the state, or society at large. On this basis, therefore, it is considered imperative that, in principle, energy policy-making actively intervenes in the household coal market, so as to encourage a shift from conventional coal to energy sources with less serious environmental problems. The development of LSC is an important component of this (as argued for EPRET by van Horen 1993 and McGregor 1993).

(ii) Legislation may be appropriate once alternatives are available

As discussed in van Horen (1993), legislation already exists which could be applied to enforce smokeless zones in townships, effectively making conventional coal use in households illegal. However, it was argued that this legislation can only be applied once alternative energy sources, which do not impose any additional financial burdens on households, are available. It is therefore proposed that, as a matter of principle, air pollution legislation could be implemented, to eliminate the use of conventional coal, once households have access to affordable alternatives such as LSCs (or electricity). This means that LSC should be priced so as to be more-or-less competitive with conventional coal. The implications of this will be made explicit below.

(iii) Encourage those LSCs which may be commercially viable

It is possible that some of the LSC prototypes may be produced on a commercial basis, either for the target market of this discussion, or for wealthier market segments. The ideal situation is one in which LSCs can be sold at prices which are competitive with normal coal and, where this is the case, these producers should be encouraged by the state to do so, by providing private sector manufacturers with a stable and transparent policy environment. This would entail, for example, making explicit government policy on conventional and LSCs – by indicating that LSC will be supported through further research, that legislation may be applied to ensure that conventional coal is replaced by preferred alternatives, and so on. This clarity and stability in the policy environment is a prerequisite for the private sector to invest in the development of low-smoke fuels which are potentially commercially viable.

Should LSCs be marketed by private sector producers, be they small-scale enterprises, or formal sector organisations, it may be necessary for the Department (of Mineral and Energy Affairs) to monitor the operation of this market so as to maintain the technical production standards at reasonable levels, and to ensure that unacceptable profiteering does not occur.

(iv) Two potential sources of subsidy finance

Assuming that some form of financial subsidy will be required to make LSC more attractive to households, there are two main sources of finance presenting themselves as theoretical options. Firstly, production costs could be subsidised directly from the fiscus – an option for which there are several possible justifications:

- Many of the benefits of reduced health problems would accrue to society as a whole, or the state in particular. To the extent that air pollution is reduced, and respiratory and other illnesses become less prevalent, the public health care service will be relieved of a burden. The effect on the fiscus of the subsidy outflow would be countered by a reduced outflow on health care expenditure.
- The state has a responsibility to improve the material living conditions of the vast numbers of people suffering from preventable health problems. In principle, therefore, it is necessary for the state to actively intervene in the domestic coal market, and this may best take the form of direct subsidisation of LSC.
- Indirect economic benefits should accrue to society as a whole and therefore also to the state, through an improvement in quality of life of many people, which can be expected to cause a general increase in productivity of those people, impacting on their income-earning activities.
- In the same way as economic benefits will result in the longer-term, so will political benefits follow, if the state is seen to be active in improving peoples' access to cleaner sources of energy.
- South African precedents exist for direct state support of fuel prices, such as the support for the AEC, Sasol and Mossgas. While the economic and social benefits resulting from these projects are questionable, the benefits resulting from LSC subsidisation are, in principle, uncontroversial. This is not to ignore the many other factors which require consideration to make state involvement effective.

A major disadvantage of this financing option is that it will impose an additional burden on the state's resources in the short term.

The second option, which is more attractive from a theoretical micro-economic perspective, would entail the internalising of negative environmental externalities. In other words, a levy would be imposed on the price of conventional coal, so as to more fully reflect its associated environmental and health costs. This would raise additional revenue for the state, which could be applied to cross-subsidise LSC's production costs. Such an approach should not, however, be confused as a general revenue-raising fiscal mechanism.

The determination of this levy amount is beyond the scope of the present discussion, but it appears from the preliminary cost-estimates available for the Enertek and UCP fuels that it would not have to be very significant to shift the price advantage in favour of LSCs. A question which arises is whether the levy should be applied only on coal sales to households, or on sales to other local consumers (primarily Eskom, Sasol, and industrial users), or indeed, also on export sales of coal. Clearly, these could have negative downstream effects: on the prices of electricity, synthetic petroleum fuels and exported coal. On the other hand, the impact on coal prices would be much smaller if spread over the higher volume of local and exports sales. For instance, if the financing requirement for LSC subsidisation amounted to, say, R60 per ton (a very cautious estimate), then an annual subsidy to completely replace conventional coal usage (currently about three million tons per annum) would have to be in the region of R180 million. If this is spread over total local coal consumption for 1991 of about 132 million tons then the price increase would amount to about R1.36 per ton, equivalent to a 4.1% increase in average local FOR (that is, Free on Rail, or ex-mine) prices (DMEA 1992:26-27). If the financing requirement is spread over total coal sales, including exports, the increase would be around R1 per ton, or 3.0% of domestic prices, and 1.2% of export prices. The effect of this on export revenue is equivalent to a similar fluctuation of approximately 1% in the Rand:Dollar exchange rate.

At a macro-economic level, the advantage of this second option is that it has a smaller impact on government expenditures. Negative macro-economic impacts may result in the short term if a levy is imposed on coal sales to export and non-household local consumers, in the form of slightly higher electricity and synfuel production costs, and reduced margins on export sales. The size of these impacts would probably be relatively small – this will be addressed in more detail in a subsequent chapter.

(v) Continued state support for low-smoke fuel development in the short term

It is clear that it will take some time before LSCs are widely available for household use in South Africa. Consequently, it is proposed that the Department of Mineral and Energy Affairs should continue to support research efforts in this area, with a view to facilitating and expediting the development of low-smoke fuels. In many respects this process is already underway, and includes a number of important areas of research and development:

- Further enhancement of the technical characteristics of the various prototype products, so as to optimise the balance between the amount of pollution emitted, easy ignition, and the length of time for which the fuels burn.

- Also necessary before mass production can commence is a better understanding of the social acceptability of the low-smoke fuels in relation to alternatives.

- Once the technical and social acceptability of the fuels is established it will be necessary to evaluate different financing and pricing mechanisms. In particular, it will be important to understand the current system of coal distribution and marketing, so that LSCs may be distributed most effectively by existing actors in the distribution chain.

- Another important issue, which will impact directly on the costs and financing requirements, is the potential for direct community and individual involvement in LSC manufacture and marketing. It may be feasible, for example, for the state to support the establishment of labour-intensive cooperatives which could manufacture the briquette-type of fuel at low cost. This would improve income-earning opportunities for poor communities and households, and simultaneously reduce the leakage of funds from townships. A range of methods of production may be feasible, and these should all be adequately investigated.

3.4 The financing of gas and paraffin interventions

Paraffin and gas will continue to be major fuels for domestic use in coming years, notwithstanding the shift to electricity following from the electrification programme. Both fuels are supplied by the major petroleum companies, with variable distribution arrangements coming into play further down the chain, particularly in the case of paraffin. The financing implications of policy proposals suggested in EPRET Paper 14B are relatively limited in relation to other policy areas, and many of these financing requirements would be met by well established private sector participants.

3.4.1 Current financing arrangements for illuminating paraffin and liquefied petroleum gas

The financing arrangements for the use of domestic paraffin (IP) and gas (LPG) differ according to the various stages of the supply and demand chain. The main components of this chain pertinent to the present financing discussion, are the households or end-users, the intermediate distribution agents, and the large petroleum industry suppliers.

(i) Household financing of IP and LPG use

A major advantage of IP and LPG as domestic fuels is that the barriers to entry for household use are insignificant compared to electricity and coal. The appliance costs (mainly for stoves, but also for heaters and lamps) are generally low enough for households to be able to afford their purchase, either in cash or through credit arrangements from retailers. Moreover, households are usually able to purchase fuels in relatively small quantities to suit their budgets, especially in the case of IP. The relative absence of financing constraints on the appliance and fuel purchase is one reason why IP and LPG use is so widespread. This is not to suggest, however, that real savings cannot still be made in the distribution cost structure. This is particularly the case where retailers extract excessive mark-ups from consumers, or where the distribution chain has an inefficient structure.

(ii) The financing of gas and paraffin distribution and marketing

Households purchase IP from a number of possible outlets. The most common, particularly in urban areas, are informal spaza shops and formal trading stores. Retailers are allowed a mark-up of 33.3% on the wholesale price although, as noted by McGregor (1993), retail prices are not monitored and often far exceed these levels. These mark-ups accrue to a very large number of retailers, many of whom trade in small volumes and earn their incomes from this on-selling.

The previous stage in the distribution chain involves the intermediaries between the oil companies and marketers. Oil companies distribute their products (not just IP) to their depots, of which there are about 178 around the country, via the Durban/Reef pipeline, and/or by road and rail transport (EDRC 1993: 59). Depots represent the wholesale level, at which prices are regulated by government. Included in the regulated price is a component called the service differential, amounting to 9.7 c/litre in April 1993, which is intended to finance the distribution costs related to delivery of IP from oil company depots to retailers. The service differential for IP is intended to be sufficient to remunerate both the oil companies for their costs and the 'routers' who subsequently distribute the products to final retailers. These routers are therefore remunerated by a portion of the service differential (6.2 c/litre), supplemented by discounts they may receive from oil companies reducing their wholesale margins. It appears that this distribution arrangement is relatively successful in maintaining a very wide distribution network for IP, although the mark-ups by intermediaries and retailers mean high end-user prices. Some of the policy proposals centre around this service differential arrangement – these will be described later.

A similar situation exists with the financing of LPG distribution. Although its price is not regulated by government in the same way, the same level of service differential is allowed for transport, handling and storage costs (9.7 c/litre). This is also split between oil companies and other private sector distributors.

(iii) Financing of supply capacity expansion
As described in EPRET Paper 14B, IP and LPG are extracted in more-or-less fixed proportions from refined oil products. The capital costs involved with refining crude oil, or with producing oil from coal (in Sasol's case) and from gas (in Mossgas' case), are very significant. The costs of each of the two synfuel projects run into tens of billions of Rands in current terms, although these costs are essentially 'sunk'. Further expansions of these refineries are not envisaged under the present industry structure. The oil companies, on the other hand, are currently expanding their refinery capacities, motivated mainly by growing demand for petrol. Additional LPG and IP supply capacity is therefore a secondary effect of these expansions. The oil companies' refinery investments amounted to about R700 million for 1992, and are expected to total approximately R6.6 billion in the period 1992 to 1995 (EDRC 1993: 64). These investments are financed entirely by the private sector oil companies, from their retained earnings, local capital and money markets and foreign capital.

It is anticipated that projected growth in demand for IP and LPG, even under the scenarios in which their consumption is highest, will be adequately supplied by existing and planned refineries. Current IP consumption by the entire household sector amounts to approximately 740 million litres per annum, and is easily met at existing levels of production (McGregor 1993). It is expected that even if consumption were to grow in coming years this could be met from current and future refinery output. The same holds for the balance between demand for and supply of LPG. Consequently, there are no real financing implications for refinery capacity which are attributable to the policies proposed around household IP and LPG use.

3.4.2 Financing of IP and LPG policy proposals

The policies proposed in EPRET Paper 14B have different financing implications because of the mix of public and private sector involvement. Each will be dealt with separately.

(i) Extend involvement of oil companies in distribution chain
The main motivation for this proposal is that involvement of oil companies further down the distribution chain will allow tighter regulation of prices than at present. This may eliminate or reduce the inefficiencies and excessive mark-ups currently occurring due to the present system of intermediaries and routers. This could be achieved if oil companies retain the discounts which they currently pass on to routers, which would provide the companies with sufficient incentive to invest in additional distribution facilities. Essentially, the same distribution arrangements would then prevail as for petrol, where oil companies distribute their product directly to the retailers.

The financial transfers under this kind of arrangement would entail a shift from the current intermediaries, in the form of reduced margins, with the benefits theoretically being passed on to consumers in lower prices. The role currently played by routers would then be spread between them and oil companies, which could also employ routers directly, so as to avoid unnecessary loss of employment opportunities. Once oil companies are involved in distribution it will also be possible to advertise and publish regulated retail prices, and to enforce them more strictly.

(ii) Encourage bulk purchase by cooperatives and micro-enterprises
The intention in encouraging bulk purchases by end-users is to be able to buy directly from oil companies, at or near to the wholesale price, without having to

finance the profits of the intermediaries. Within this overall policy suggestion, there may be several alternatives. Firstly, service-station operators may be provided with finance from oil companies to install bulk tanks for IP and LPG (as for petrol and diesel), which would then be able to supply households and small-scale enterprises directly. Secondly, cooperatives could be established to buy the bulk quantities of IP and LPG. These would require fairly extensive support services from various sectors, regarding the technical, marketing, administrative and financial services they would have to perform. This support would be significant if taken in isolation from any other similar initiatives, but it may be possible to dovetail such cooperatives with others which may be established around building materials, agricultural produce, and so on. In this case, the extension support which would be required would benefit a number of aspects of community involvement. In the case of IP and LPG cooperatives, it would be necessary for the oil companies to be involved, at least to ensure that technical and safety standards are adhered to, and they may therefore also be able to play a bigger role in financing the extension support services required for these cooperatives.

A third option is to encourage the establishment of IP and LPG depots which would benefit from bulk purchase discounts and which would still be close enough to consumers to give them easy access to fuels. It is conceivable that viable small-scale enterprises could be established with the support of oil company and development finance institutions (such as the SBDC and DBSA) along similar lines to community-based cooperatives.

(iii) Child-resistant paraffin containers and lids

Paraffin poisoning is a relatively common incident in IP-using households with children, especially those in which there are infants between 12 and 36 months of age. In many cases, IP ingestion results in severe poisoning, and sometimes death. Consequently, as argued elsewhere, the prevention of IP poisoning should be regarded as a major area for public policy intervention.

There appear to be four main areas for intervention:

- education and publicity measures around the dangers of paraffin poisoning;
- production and use of child-resistant lids for existing containers;
- production and use of containers to match the child-resistant lids; and
- in the long term, possible legislation to tighten up safety regulations.

In principle, the responsibility for financing these interventions lies in the first place with the private sector players whose products are concerned (mainly the oil companies), and secondly with the government which has a significant overall responsibility for maintaining public health. It can be expected that a real expenditure saving will accrue to the government in the form of reduced health care for poisoning victims, once policy interventions begin to have an effect. Nonetheless, an argument for government intervention cannot rest upon an assumption that it will realise a direct saving on health care expenditure.

Firstly, education and publicity programmes (such as visual posters) should be aimed at adults and older household members to keep IP in safe containers and out of the reach of infants. The costs of such programmes should be borne jointly by government and the producers.

The most significant impact may be derived from child-resistant lids (or closures). The Medical Research Council (MRC) is currently centrally involved in research into the kinds of lids which might be used on the existing containers in which people currently store their IP. These containers include, commonly, used bottles from alcoholic and other beverages. It is expected that lids will be designed at a cost of around R1 each, and it is possible that the lid-manufacture process may be suitable for decentralised production by small-scale enterprises in townships (De Wet 1993). It is probable that in practice there will be a need for both mass-production plants and these smaller micro-enterprise-based processes. From the initial research conducted by the MRC, it appears that communities would respond favourably to this kind of intervention, and that they would be willing to pay the full price of such a lid if it is in the region quoted. Consequently, there is potential for this to be a financially viable project which can operate on a cost-recovery base, and perhaps even generate incomes for small-scale manufacturers. This would require the same institutional and technical support as any other small business. In addition, establishment costs would have to be financed for manufacturers, so that institutions such as the SBDC, DBSA and the government should assist producers to gain access to the necessary finance.

A subsequent phase may involve the design and production of containers, which would probably be designed so as to fit the lids produced in the first phase. This is an area, however, which requires further research into the acceptability of various container designs and the willingness of households to pay for them. It appears that this option may be more costly than the first. Similar financing and pricing arrangements will probably apply to this stage.

3.5 Demand-side management and efficiency policies

Demand-side management (DSM) and energy efficiency policies are an integral part of the IEP methodology, yet they have until recently received relatively little attention in South Africa. Consequently, there is a lack of experience and of institutional support for this approach in the country's energy sector, and so policy proposals around DSM and efficiency represent, in many respects, the first such attempt in South Africa. As there is relatively little existing experience to draw upon, this section therefore describes some of the financing implications of the main DSM policy proposals.

There are four main DSM policy options which have been identified in EPRET (Thorne 1993):

- upgrading existing houses and constructing new houses so as to achieve good thermal performance;
- promoting energy-efficient appliances such as compact fluorescent light (CFL) bulbs and solar water-heaters;
- labelling appliances to indicate to consumers their energy consumption characteristics and life-cycle costs; and
- implementing time-of-use (TOU) tariffs to encourage more efficient use of electricity.

Some of these policies have been presented as illustrative options and, given that none have yet been implemented in South Africa, the next section assesses the impact of financing policies on their potential success.

3.5.1 Financing arrangements for DSM and efficiency policies

Many energy efficiency policies face financing constraints. Frequently they entail a larger initial investment, which then results in subsequent savings. When faced with a choice of two investment alternatives, an energy-efficient option and a conventional option, a consumer without any financing constraints would choose the option with the most favourable net present value. If the present value of future savings from the efficient option exceeds the additional initial investment, then the consumer should choose that option. This would be the case, for example, with an energy-efficient CFL bulb which, although it costs more, saves a greater amount of energy over its lifetime.

In practice, however, especially where poor households are concerned, the lack of liquidity and of access to finance imposes severe constraints on their ability to invest in energy-efficient options which cost more initially. From a policy perspective it is therefore essential that financing arrangements be put in place to overcome these barriers. External support is essential, since poor households will generally be unable or unwilling to make larger upfront expenditures to realise subsequent savings.

Thermal performance upgrades and efficient appliances

The principles described above apply to the policy options of installing insulating ceilings and materials in new and existing dwellings, and to encourage the use of efficient appliances such as CFL bulbs and solar water-heaters. It has been estimated that expenditure of R500 to R1 000 per dwelling would result in significant savings in their energy consumption (Thorne 1993). In the case of electrified dwellings, Eskom estimates that winter space-heating contributes about 1kW to the after-diversity-maximum-demand (ADMD) of households, since all households require heating at the same time and there is little benefit from diversity. Further, they expect that roughly half of this could be saved through thermal upgrades of those dwellings. Likewise, the use of efficient appliances such as CFL bulbs would reduce the amount of energy consumed by households as well as the generation requirements of Eskom.

Since the benefits of such savings accrue both to the household and to the electricity utility in the case of electrified dwellings, it may be argued that Eskom should assist households in the financing of such DSM interventions. In the case of unelectrified dwellings, benefits would accrue to the household in the form of lower energy expenditures, but there is no institution as well placed as Eskom to assist in the financing function. Consequently, finance could be channelled through housing delivery and development agencies.

Time-of-use electricity tariffs

The financing implications of TOU tariff implementation are different from the previous policy options. The main costs to be borne by the utility relate to the metering and billing requirements for TOU administration. With TOU meters currently costing about R1 000, the total costs of a move to this tariff system will not be insignificant. It is possible that these costs will decline with time as economies of scale are achieved and design improvements are effected, as was the case with prepayment meters.

Initially TOU will be applied only to high-consumption consumers who are able to shift their loads to off-peak periods and, as consumers will initially have a choice to move to TOU, it is unlikely that the meter costs will be incurred immediately for all consumers in this category. Nonetheless, assuming that one million consumers switch to TOU, and that average meter costs are, say, R600 each, then total costs will be about R600 million. Ligoff has estimated that TOU tariffs can result in a shift of an average 10% of such consumers' loads to off-peak periods (1993: 12), equivalent to a projected saving on peak demand of 400MW for one million consumers. Since this represents a significant saving for Eskom in the long term, the initial investment in TOU meters and related systems may be justifiable.

Appliance life-cycle cost labelling

This policy option has relatively limited financing implications, since the costs of such a proposal will be borne by the manufacturers of appliances such as refrigerators, freezers, washing-machines and stoves. Manufacturers would be required to include information on existing labels and packaging, informing purchasers of the appliance's energy-consumption characteristics. Generally they should already have such information available and, where not, this would not be particularly costly to establish, so that additional costs should not be serious.

Allied to the labelling process, is the need for independent testing and verification of manufacturer claims, by an institution such as the South African Bureau of Standards (SABS). Again, the financing implications of this additional verification procedure, which will supplement a range of existing procedures, should not be significant.

In conclusion, it should be emphasised that the effective return on investments in DSM measures is generally far more favourable than investments in expanding supply capacity by the equivalent amount. The investment requirements of compact fluorescent bulbs, for example, are relatively modest in relation to the avoided future investment in additional generation capacity. Ligoff (1993: 27) has estimated that if 50% of all lights installed in the next ten years are CFL bulbs, the saving on Eskom's peak demand would be about 1 200MW. According to Eskom's calculations of its marginal costs (including additions to generation capacity), this would result in a cumulative saving or avoided cost (in 1993 Rands) of R1.6 billion (Ligoff 1993: 44). It is not clear what the equivalent investment in CFL bulbs would have to be, but at an average of R40 per CFL bulb, this would be sufficient for 40 million light bulbs, or 13 CFL bulbs for each of about three million electrified households. This probably exceeds the number of bulbs required to result in a 50% substitution effect, and would therefore point towards the DSM strategy being the more cost-effective option.

CHAPTER FOUR

Impact of household energy policies on the macro-economy

4.1 Introduction

An important component of the integrated energy planning (IEP) process is the assessment of whether the policies and plans suggested during the research phase are realistic and achievable within overall resource constraints. If the prevailing macro-economic conditions are likely to impose constraints on household energy policies, then an iterative process must be entered into, whereby policy proposals are adjusted until they are feasible on a macro-economic level.

This chapter assesses the possible macro-economic impacts of the two main investment scenarios which may apply to household energy policy until the end of the next decade. These scenarios were more fully described in section 2.5:

- a 'business as usual' (BAU) scenario, in which current trends follow their present course and in which no major policy interventions occur; and
- an 'integrated energy planning' scenario, in which a range of policies are implemented with the aim of widening household access to energy services.

Clearly a wide range of macro-economic variables could be considered, and the methodology employed could vary equally widely in its rigour and empirical strength. The aim here is to assess, for the most important variables, and about which sufficiently reliable information exists, the *order-of-magnitude* impacts of policy options. This will indicate whether the policies proposed under the scenarios are feasible in the light of available resources. The present exercise is not intended to be, or to substitute for, a thorough and sophisticated modelling process, but it can give an approximate indication of the macro-economic effects of policy proposals. The macro variables considered are as follows:

- investment levels;
- fiscal revenue and expenditure;
- balance of payments;
- employment; and
- environmental quality and sustainability.

The last two variables are sometimes not included in conventional macro-economic analyses, but are considered important in the present study, because of the importance attached to the development goals of equity and sustainability. It is obvious that, in some cases, policy proposals may have little or no impact on some of these variables.

This chapter is organised as follows: each of the macro variables will be considered in turn and for each variable the impacts of both scenarios will be assessed, allowing the impacts of the two scenarios to be relatively easily compared.

4.2 Impacts on investment levels

In many respects this is the most crucial macro variable, as it represents the total amount of investment required to implement policies. If other demands (such as for housing, education, construction and private investment) against available funds (in capital or money markets, locally and overseas, and in private savings) are very high, then insufficient resources may be available for household energy investments. Provided that adequate sources of savings can be identified and mobilised energy investments may be able to proceed, particularly if other sectors are not faced with shortages of investible funds.

The investment requirements of each scenario are assessed below. For each scenario, the major subsectors in which policy recommendations have been made, are addressed in turn.

4.2.1 Scenario one: business as usual

(i) Electrification

Capital investment in the expansion of the electricity grid and reticulation systems will account for almost all of the investment under this scenario. In 1992 the capital amount expended by Eskom on electrification was about R450 million, with local authority distributors accounting for about R150 million. The total of R600 million represented about 1.2% of Gross Domestic Fixed Investment (GDFI) for 1992 (SARB 1993: 92). Moreover, GDFI is currently at low levels in relation to GDP: only 15.9% in 1992, compared to more 'desirable' benchmark levels of about 25% (ibid).

Under this scenario it is expected that the rate of connection may increase to about 250 000 for several years, before experiencing bottlenecks related to financial and structural constraints related to the fragmented nature of the distribution industry. At average connection costs (in 1993 Rands) of about R3 000 each, the maximum annual investment requirements would be in the region of R750 million, equivalent to 1.4% of GDFI. From a macro-economic perspective therefore, this electrification scenario would probably not be constrained by capital shortages and, in turn, would have a minimal impact on the availability and cost of capital for other sectors of the economy.

(ii) Other supply and demand sectors (fuelwood, hydrocarbons, DSM)

Under the BAU scenario, relatively little new capital expenditure would be made for the purpose of household energy use in the fuelwood, hydrocarbon and demand-side management sectors. The most significant impacts related to these policy areas occur in the IEP scenario.

4.2.2 Scenario two: integrated energy planning

(i) Electrification

Under the IEP scenario, the levels of capital investment by electricity supply authorities will be considerably higher than they would otherwise have been. On the other hand, however, the tariff proposals (for a national flat-rate tariff) will have a considerable impact on the financing requirements for the supply industry, especially if tariffs are set at a level which causes a transfer from high-consumption users to newly electrified consumers. Therefore, in addition to the investments in respect of the capital costs of new connections, there will be two further influences on the ability of the supply industry to finance this investment:

- The financing requirement will be increased by the accumulated operating losses incurred in respect of under-recoveries from new customers who are being cross-subsidised by high-consumption users.
- On the other hand, the financing requirement will be met partially from the surplus generated by high-level consumers and those whose capital connection costs have been paid off.

These two effects are especially important to the electricity supply industry, since they will determine the extent of the industry's financing requirement and thus the impact on debt:equity levels. These effects, however, will not diminish the total investment by distributors (the subject of the present section) and are therefore considered separately in Chapter 5.

Using an average cost of R3 000 per connection, as in the first scenario, the total investment under the electrification programme will rise from R900 million in 1994 and peak at R1.5 billion per annum from 1997 (500 000 connections). The rate of connection would taper off gradually after the turn of the century, until stabilising at around 250 000 connections per year from about 2007, sufficient to keep pace with the rate of new household formation. The peak level of investment, at R1.5 billion per annum in 1993 Rands, is equivalent to just 2.9% of GDFI in South Africa for 1992, and is therefore unlikely to impact significantly on interest rates. Over 17 years from 1994 to 2010, the programme will entail a total capital investment of nearly R22 billion, based on the electrification of about 6.6 million households, which will result in about 86% of all households in 2010 having access to electricity.

(ii) Fuelwood policies

Some of the expenditure which will be required in the fuelwood sector under the IEP scenario, will certainly increase the productive capacity of households, communities or institutions and might therefore be classified as 'investment' rather than 'current expenditure'. However, because of the relatively short life of many such investments, such as in establishing woodlots and agroforestry programmes, it would be more prudent to exclude these from productive investment and include them instead in the 'expenditure' category.

An exception to this may be the additional investments envisaged for commercial forestry companies under their small-grower schemes. Based on estimates by Gandar, these investments may amount to about R80 million initially and a further R75 million over the first seven-year rotation period, giving a total of about R150 million.

(iii) Low-smoke coal

In order for low-smoke coal (LSC) to be produced on a large enough scale for it to have an impact on household consumption, some investment will have to be made in production capacity. This level of investment differs, however, according to the type of LSC being considered. For present purposes, it is assumed that the most expensive of the three products mentioned earlier, 'Wundafuel', will be produced commercially for a better-off market segment than the focus of this study. Any investment made for this fuel will therefore be done on a commercial basis.

The UCP/Wits heat-treated fuel is the more capital-intensive of the other prototypes, as it utilises waste heat to drive off the volatile compounds. Consequently some capital investment may be required if this product is to achieve a significant penetration of the target household market (which consumes some three million tons of coal per annum). As no detailed analysis has yet been made of this product's potential, it is not possible to estimate the amount of investment required, but it is clear that the order of magnitude will be in millions (at the most). While this may be significant for an individual manufacturer and may cause the production cost of the fuel to increase, it is insignificant on a macro-economic level.

The Enertek cement-based low-smoke fuel is much less capital intensive, requiring little investment to be feasible. It can be produced on a large scale, in a factory, in which case a number of cement mixers and slab-casting machines may be desirable. More interesting for its employment effects, however, is the option which entails decentralised production by small-scale enterprises, cooperatives and individuals. In this case, the minimum requirements are a shovel and wheelbarrow, with a cement mixer being an optional extra. The investment requirements are therefore minimal.

(iv) Gas and paraffin

Policy proposals around liquefied petroleum gas (LPG) and illuminating paraffin (IP) have two aspects: those aimed at reducing the prices for both products paid by end-users, and safety measures aimed at reducing the risks of paraffin poisoning for young children. Neither of these have very significant investment requirements. In the case of the former, the oil companies may make additional investments in the distribution network (for example, the installation of IP tanks alongside petrol and diesel tanks), but these are likely to be financed entirely from private capital and are not likely to be significant on a macro-economic scale. Likewise, the costs of establishing production facilities for child-resistant paraffin lids are not likely to be significant on a macro scale.

(v) Demand-side management

There are three DSM policies which have notable investment requirements:

- the metering systems for time-of-use (TOU) tariffs,
- the capital costs of energy-efficient appliances, and
- the costs of thermal performance upgrades.

As noted in Chapter Three, DSM is a relatively new area in South Africa and no detailed costings have been made for these interventions; nonetheless, a few estimates can be made. With TOU meter costs currently at around R1 000, but expected to drop as economies of scale and design improvements are achieved, and possibly one million households likely to switch to TOU once the option is available, the investment requirements will be significant. Assuming that meter costs drop to about R600 each, the investment requirements will be in the region of R600 million. This amount, however, will be expended over a number of years as and when people make the switch to TOU. Consequently, the annual investment will be much smaller.

The most attractive of the energy-efficient appliances is probably the compact fluorescent light-bulb (CFL), at an average cost of about R40 each. If an ambitious programme were established to encourage their use by all electrified households, and their costs were financed by electricity distributors and recovered through the tariff or some other mechanism, then the investment requirements would be in the region of R240 million for the existing three million customers if each household were to purchase two CFLs. If newly electrified households also purchase two bulbs each, the investment requirements (to be financed by utilities) will rise from R24 million in 1994 to R40 million at the peak of the programme.

Finally, sizeable investments would be required to install efficient insulating materials in formal and informal dwellings where this is lacking. Such investments could fall into two categories: upgrading of thermal performance of *existing* dwellings, and investments in *new* dwellings. In respect of the latter, Ramsay (1993) has argued that it is possible to construct a dwelling which has a thermal performance to eliminate or significantly reduce the need for space heating, at no additional cost to conventional building methods for low-cost housing. Consequently, there could theoretically be no additional investment requirements for new dwellings. In upgrading existing dwellings an investment of R500 to R1 000 may be required per upgrade (Thorne 1993). Assuming that upgrades will be justifiable for all urban informal dwellings in the temperate climatic zone, and for 50% of formal dwellings in this zone (regions A, D and H), then a total of about 1.8 million upgrades may be required. At an average cost of R750 per house this will require a total investment of R1.35 billion. This is significant in relation to the other policy sectors addressed in this paper.

The other side of this coin is the *avoided investment* in generation capacity attributable to reduced demand for electricity. Based on such a calculation it has been shown that the avoided costs of installing new generation capacity, due to the savings in demand from these interventions, far exceed the amortised investment costs of these DSM interventions (Thorne 1993). Over time, therefore, the net investment requirements for DSM strategies combined with electricity generation will be reduced by these interventions.

4.3 Impacts on fiscal revenue and expenditure

This refers mainly to the outflows from the fiscal authorities, such as for subsidisation of capital infrastructure or for research, as well as the inflows from income tax, expenditure tax (such as VAT) and other duties and levies. Clearly, any policy which makes a claim on the government's budget will have to be justifiable on grounds of, for example, equity or public health. Given that the 1992/93 excess of expenditure over revenue is very high, at R28.6 billion or 8.6% of GDP (as reported in the Minister of Finance's budget speech, McGregor 1993), it is clear that the government budget will have to be tightly managed in coming years.

4.3.1 Scenario one: business as usual

(i) Electrification

There will be no *direct* effects on the fiscus associated with electrification, for the following main reasons:

- No state subsidy is envisaged under this scenario; instead electrification will be financed by Eskom and local authority utilities.
- Even though Eskom is a public corporation, it does not have any direct impacts on the fiscus. Notwithstanding its large capital requirements it is completely self-financing, either through operating surpluses or external borrowings. On the revenue side, it does not pay income tax.
- The other major source of finance for electrification, under the present structure of the industry, is from local government. Historically white local authorities meet their financing requirements from external debt, accumulated reserves or from trading surpluses, while black local authorities are unlikely to play any role in electrification.

Electrification does, however, have some significant *indirect effects* on government revenue and expenditure. Firstly, electrification costs include expenditures which are subject to indirect government tax. An approximate breakdown of the average connection costs of R3 000 is as follows (EDRC 1993: 9):

Materials	60%	R1 800
Labour	25%	R750
Transport	4%	R120
Overheads	11%	R330

Value added tax (VAT) is levied on the materials and transport components of connections costs, which would have amounted to about R175 per connection in 1992 (at 10% VAT). At a VAT rate of 14%, government revenue will benefit by about R245 per connection in current terms. Secondly, the labour and overhead components of electrification costs will include revenue sources by way of income tax which, at an average tax rate of, say 15%, amounts to additional revenue of about R160 per connection in current Rands. The net effect on the fiscus of electrification will therefore be just over R400 per connection. At an annual connection rate of 250 000, these taxes will result in an inflow for government of about R100 million per annum. This is about 0.1% of total government revenue for 1992/93 (McGregor 1993).

Government revenue may benefit further from indirect tax sources, assuming that newly-electrified households spend more of their incomes on consumable and durable goods, such as appliances, food, and so on. These effects are very indirect, however, and depend upon a number of uncertain factors, such as the disposable incomes of households, and access to credit for purchase of appliances.

It should also be noted that the state bears large health costs which are related to the use of polluting fuels such as coal and wood, and to incidents of trauma, such as burns and paraffin poisoning from accidental ingestion. It is clear that the health effects carry enormous economic and social costs (Van Horen 1993). The state health-care system carries the bulk of the resultant burden, so some savings may be anticipated, although these effects will be relatively modest under this scenario since coal and wood use will be largely unaffected.

(ii) Other supply and demand sectors (fuelwood, hydrocarbons, DSM)
Under the BAU scenario negligible public expenditure would be undertaken in the fuelwood, hydrocarbon and demand-side management sectors. Likewise, no additional sources of government revenue would accrue.

4.3.2 Scenario two: integrated energy planning

(i) Electrification
Under the BAU scenario, it was envisaged that the effects on the fiscus would be limited to indirect revenues accruing via income tax and VAT attributable to electrification expenditure. In the IEP scenario, however, there will be one important additional effect on the fiscus, in respect of direct state support for the electrification programme: this in turn, will have at least two elements: capital subsidies for electrification, and support for the Electrification Fund (EF).

Capital subsidies for electrification
It has been proposed that where connection costs exceed an agreed-upon parameter (of, say, R3 500), households should receive a lower level of supply, or should contribute resources in order to lower these costs, or external subsidies should be provided to lower the cost to the utility (Pickering 1993). In practice this is likely to apply especially to rural households which are far from the existing grid, or widely dispersed.

Poor information exists on which to base estimates of the possible subsidies required to connect a reasonable portion of these households to the grid or to a remote area power supply (RAPS) system. However, using rough estimates based on available information, it appears that the total rural population of about 3.2 million households includes roughly 0.9 million farmworker households, most of which may be connected within the proposed parameter of R3 500 (Hofmeyr 1993). Of the remaining 2.3 million households (mostly in the 'homelands'), it is likely that connection costs will be higher, even for lower levels of supply. Assuming that capital costs (grid or RAPS) will be an average of R6 000, and that 55% of this group will be electrified by 2010, then about 1.3 million households will be electrified in this category. Under such a scenario, total state expenditure over the life of the 17 year programme will be in the region of R3.3 billion. At its peak this portion of the rural electrification (RE) programme will cost the state only about R250 million per annum. In terms of the social and economic benefits resulting from RE, this appears to be a highly desirable item of expenditure for the state.

The mechanism for the disbursement of this subsidy finance should be the EF, as argued earlier in this paper.

Guarantor for an Electrification Fund
An essential feature of an EF is that it should include a base amount of seed finance for the Grant Fund, which can then act as a loan guarantee fund (or security) for the private loan finance managed by the Loan Fund (see Chapter Three). It is envisaged that the state should make the first and basic grant to this fund, and that this should be in the region of R0.5 to R1 billion. This would be a one-off grant, which would in principle be of a capital nature and therefore not drawn down by ongoing expenditure. In practice, it is possible that additional commitments may be forthcoming from the private sector as well as foreign donors.

A second feature of the state's commitment to the EF would be the guarantee of the Grant Fund's obligation to make up any shortfall in the Loan Fund's repayment to lenders – essentially the difference between the guaranteed minimum return to investors (say 10%) and the actual return derived from electricity revenue. In effect, this represents a subsidy for low-level electricity consumers. It is extremely difficult to estimate the level of this commitment, since it depends on many unknowns: the growth in consumption of new customers, the basis of calculating returns to lenders, and so on. For illustrative purposes, however, assuming average monthly consumption is at the lower end of the scale, say 100 kWh per month, that the flat-rate tariff is at 20 cents per unit, then at the peak rate of 500 000 connections the total revenue from these newly electrified consumers will be about R120 million. Using the same structure as Eskom's Electrification Bond (for illustrative purposes), the return payable to investors would be the base rate of 6% (6% of R1 500 million is R90 million) plus 30% of this revenue (30% of R120 million is R36 million), amounting to a total of R126 million or 8.4% on the capital investment. If the guaranteed minimum return were to be the same as Eskom's first EPN bond issue (80% of the E168, equal to nearly 12%), which is fairly generous to investors, then the shortfall would be 3.6% on the capital amount of R1 500 million, or R54 million. In other words, this is the amount which the Grant Fund would have to transfer to the Loan Fund to provide investors with their guaranteed minimum return. In fact, this would not require any additional state transfer to the Fund, since the Grant Fund would generate more than this amount in income on initial seed finance of R0.5 billion (R0.5 billion at 15% for only 1 year is R75 million). Consequently, there will be no further demand on the fiscus once it has invested the original seed finance in the Grant Fund.

In summary, the total drain on the fiscus associated with this kind of electrification scenario will be the ongoing capital subsidies for electrification of mainly rural households, which peaks at R250 million and amounts to about R3.3 billion over the life of the whole programme, and the initial one-off injection of between R500 million and R1 billion into the Grant Fund of the EF.

Revenue inflows due to electrification

As in the BAU scenario, the state will benefit from a number of indirect inflows due to income tax and VAT arising out of capital expenditure under the programme. Assuming that, as before, each connection results in an inflow of about R400 in respect of these taxes, the total revenue will double from present levels to about R200 million per year. This almost fully offsets the capital subsidy required for the consumer class described above.

As before, there may be further benefits from indirect tax sources, once newly electrified households spend more of their incomes on consumable and durable goods, such as appliances, food, and so on. These effects are very indirect, however, and are not quantified in this paper, even though they may be very significant in practice.

Further, it should also be noted that the state may realise additional savings in health care expenditure due to reduced health problems resulting from coal and wood combustion, paraffin poisoning and burns and fires.

(ii) Fuelwood policies

The main macro-economic impact of fuelwood policies will be on government expenditure. Apart from expenditure which is allocated to rural development functions through departments such as forestry, agriculture and energy, and which is directed towards the policy of securing wood supplies from natural woodlands, there are two main areas in which additional state expenditure is envisaged.

Firstly, the network of nurseries oriented towards social forestry programmes, as described in Chapter Three, will cost in the region of R70 million to establish and

R40 million per annum thereafter to maintain. Clearly the initial expenditure would not be incurred in a single year and would gradually build up to the point where the full network has been established, after which only maintenance costs would be incurred. The peak expenditure would then be about R40 million per annum (in 1993 Rands) and would come from the range of government departments which are concerned with rural energy and development.

The second main item of government expenditure will be in respect of woodlots and plantations which, under the scenario described earlier, would cost about R260 million to establish. Again, this would be incurred over a period of more than one year, so that the annual burden on the fiscus would be considerably lower: perhaps about R60 million for four years.

(iii) Low-smoke coal

In the short-term, LSC will require direct state support if product development is to reach the point where mass production is possible. This support will principally take the form of funding by the Department of Mineral and Energy Affairs (DMEA) of research into the feasibility of the existing prototypes. Such a research programme already exists within the Energy for Development section of the DMEA and should continue until sufficient clarity exists over the viability of the options currently being pursued. The extent of this state expenditure is only a few million rand.

Thereafter, in the longer-term, it is possible that state support may be required to give LSCs a price advantage over conventional coal. The Wits/UCP fuel may not require this support (Horsfall 1992), while in the case of the Enertek variety this subsidy may amount to a maximum of about R180 million per annum (see section 2.2). This is less than half of the 1993/94 allocation to the Atomic Energy Corporation (AEC), and 25% of the DMEA's total budget (auf der Heyde 1993). On the other hand, savings would be likely to accrue to the state in respect of reduced health care expenditure resulting from reduced respiratory illness in coal-using households. The second option for the financing of LSC described earlier, namely the imposition of tax on conventional coal, would be revenue-neutral for the fiscus if the tax was levied at a level of about R1 per ton.

(iv) Gas and paraffin

The first area of policy, around the IP and LPG distribution and retailing network, is likely to be fiscally neutral, since investments and expenditures will be carried out by private sector players such as the oil companies.

With regard to the health and safety effects of paraffin and gas, it has been argued that the primary responsibility for the safety of users rests with the suppliers of those products and that the state should not have to make direct expenditures in respect of, for example, reducing paraffin poisoning. Nonetheless, it is possible that the government will have to support small-scale enterprises or community cooperatives which could produce the child-resistant lids. This kind of support, however, will probably be channelled through existing institutions such as the Small Business Development Corporation with their existing budgets. Any additional state expenditure will therefore be small.

(v) Demand-side management

Energy efficiency policies are unlikely to have any direct effect on government revenue and expenditure, unless the state embarks on a programme to invest directly in household efficiency, for example, in the form of thermal upgrades. However, most of these interventions could be of a loan rather than grant nature, because households should benefit directly in the form of reduced energy expenditure, and could apply a part of these savings to finance the initial investments. Other indirect effects on the fiscus may arise through shifts in the allocation of research budgets, and in the monitoring of efficiency practices such as appliance labelling. These, however, will not be significant.

(vi) Total fiscal requirement of IEP policy proposals
The combined effect of the IEP policy proposals on the fiscus will be relatively modest. More significantly for present purposes, the fiscal expenditure requirements could be met fully from the existing fiscal allocation to the AEC. The estimated government cash-flows described in this section are summarised in Table 4.1.

Policy proposal	*One-off expenditure Rm*	*Annual expenditure Rm*
Electrification: capital subsidies	—	250
Electrification Fund: seed finance	500 – 1 000	—
Electrification: taxation income	—	(200)
Fuelwood: nurseries	70	40
Fuelwood: woodlots (about 4 years)	—	60
Low-smoke coal	—	0 – R180
Total expenditure	570 – 1 070	150 – 310

TABLE 4.1 Summary of estimated one-off and annual fiscal expenditure and revenue resulting from IEP policy scenarios (Rands 1993)

It is evident from the table that net fiscal expenditure required for these policies will be relatively small. Even if indirect revenue associated with electrification (VAT and income tax) is *excluded* from the above figure, and if the *maximum* possible government subsidy of LSC is included, then total government expenditure would need to be R560 m. By comparison, the 1993/94 fiscal allocation to the AEC was R474 million and to the DMEA was R708 million (see Chapter Two). At its peak, the government allocation to the nuclear industry was R776 million (in 1986/87 Rands) which, in today's terms, is well in excess of the amounts being proposed in the present project. Consequently, a very strong case may be made for a shift in government spending away from the AEC (which has, in any case, delivered highly questionable results) towards the policies identified in the IEP scenario, which will have a significant impact on the welfare of large numbers of people, as well as producing real economic benefits.

4.4 Impacts on balance of payments

The balance of ayments is frequently posed as a potential constraint on ambitious development projects such as electrification, insofar as the foreign exchange requirements for imports may draw heavily upon foreign reserves.

4.4.1 Scenario one: business as usual

(i) Electrification
The balance of payments implications of an electrification programme have three main aspects, which will be discussed separately:
- direct imports of the some of the materials required for connection to an electricity supply;
- second-round (and subsequent) leakages stemming from appliance purchases by newly electrified households;
- potential foreign exchange gains from the export of commodities produced for a national programme.

Direct imports
Of the average connection cost of R3 000 given earlier, it has been estimated that the imported portion of materials requirements are around 20%, equivalent to about R360 per connection (EDRC 1993: 9). These imports include components of transformers, electronics and chemical inputs. Imports included in labour and overhead costs are negligible, although transport costs are likely to have a relatively high import component (say 70%). This will bring the cost of imports to, say, R450 per connection, or 15% of total cost.

Assuming that the Rand more or less maintains its current level against foreign currencies, the annual import bill in respect of these direct costs will be in the region of R112.5 million, equivalent to 0.2% of 1992 imports (SARB 1993: 92).

Import of appliances and capital equipment
Import leakages are likely to occur in the second-round and subsequent effects of electrification during which electrical appliances are purchased by newly electrified households. The South African appliance sector may be divided into three categories, with the following market values and import propensities (Baumann 1993):

1. Consumer electronics (TV, radios, audio-visual equipment): current market value is approximately R1 800 million per annum, of which an average of 42% is imported.
2. Small appliances (kettles, irons, toasters, etc): market value approximately R339 million, of which about 66% is imported.
3. Large appliances/'white goods' (refrigerators, freezers, washing machines, stoves, etc): market value approximately R1 600 million, 13% of which is imported.

The South African electrical durables sector is currently functioning well below capacity and faces strong competition from foreign producers who generally are able to achieve the economies associated with large-scale production. Moreover, it is not expected that electrification will by itself give a major boost to the local appliance industry because of its poor competitiveness in relation to foreign producers. Detailed forecasts have not been made, but rough estimates are possible. Assuming that households spend an average of R200 on new appliances, and an average import propensity of 30%, appliance imports will amount to R60 per connection. With these assumptions under the BAU scenario, imports would be about R15 million per year, which is hardly significant.

Clearly, the more money households spend on new (as opposed to second-hand) appliances after electrification, the higher the import cost.

Potential exports resulting from electrification
Many indirect balance of payments benefits may result from electrification, through, for example, improved worker productivity due to better living standards, which may ultimately be reflected in greater competitiveness and exports; however, these effects are too indirect to be quantified for the present purposes. One spin-off from an electrification programme which has direct export potential is in the manufacture of prepaid meter systems (also called electricity dispensers, EDs, or budget electricity controllers, BECs). Even though approximately 40% of the value of the finished product is imported (mainly electronic components and parts of the casing), there is good potential for economies of scale and therefore exports. According to members of the industry, considerable interest has been shown by countries in Latin America, Africa and the Middle and Far East, with potential demand in the long term likely to far exceed supply capacity from South African producers.

It has been estimated that existing productive capacity can supply approximately seven times current domestic demand: in the region of 1.4 million EDs per annum. At an average unit price of about R350 per ED, the export market is potentially very large. After accounting for domestic demand for EDs, sufficient capacity exists to produce about one million units for export annually, without any major new investment in productive capacity. Before this market materialises, large orders for EDs will have to be secured from countries involved with electrification programmes of their own. On the other hand, the South African export market may be undermined by low-cost manufacturers, such as those in Taiwan or South Korea. With the large number of unknown variables in the export equation, it is very difficult to predict the likely size of the ED export market.

Although some pilot export projects are underway at present, it is unlikely that exports will increase substantially in the next year or two. Thereafter, it is possible that volumes will increase and, assuming that 100 000 units could be exported, net export revenue of about R21 million per annum would result. This is insignificant on a macro scale, but would offset the foreign exchange leakages in respect of appliance imports.

The aggregate effect of these three factors on the current account is an outflow of just over R100 million per annum, which is very insignificant in relation to current imports and exports. The balance of payments is therefore not likely to act as a constraint on electrification under the BAU scenario.

(ii) Other supply and demand sectors (fuelwood, hydrocarbons, DSM)
Again, under this scenario, no major balance of payments impacts would occur for the fuelwood, hydrocarbon and demand-side management sectors.

4.4.2 Scenario two: integrated energy planning

(i) Electrification
As in the first scenario, three impacts of an electrification programme on the balance of payments will be considered:

- direct imports of materials required for connection;
- subsequent leakages due to appliance purchases;
- potential exports associated with electrification.

Direct imports
With approximately 15% of expenditure on connection costs flowing out of the country, or R450 per connection, the IEP scenario will cause imports to rise to R225 million per annum at the peak of the programme – equivalent to less than 0.4% of 1992 imports (SARB 1993: 92).

According to an Eskom investigation, suppliers of locally-sourced components will be able to satisfy much higher levels of demand without having to invest in any significant new capacity. The first anticipated bottleneck is expected to occur in the supply of concrete poles; however, it is easy to expand their production capacity, and they are in any event readily substitutable by wooden poles. Thereafter, the next constraint occurs at a rate of about 700 000 connections per annum: well in excess of the peak rate of total planned connections under the IEP scenario.

Import of appliances and capital equipment
Using the same analysis as for the BAU scenario, based on appliance imports of R60 per connection, imports would then rise from about R18 million per annum in 1994, to about R30 million from the peak of the programme in 1997. Clearly, these levels are insignificant.

Potential exports resulting from electrification
It is difficult to estimate the potential for exports of products such as electricity

dispensers (EDs) under the IEP scenario, as it is not clear whether a scaled-up domestic electrification programme will have any influence on the size of export orders. At the very least, therefore, the same levels of export volumes as under the first scenario may be realised, equivalent to about R21 million per annum. It is *possible* that export volumes may increase if the increased domestic demand provides local industries with a springboard for exports: economies of scale in production can be more easily achieved, local markets will provide a testing ground to encourage foreign purchasers to invest in these products, and local manufacturers will have added experience compared to foreign competitors. On the other hand, it is possible that South African producers may be undermined by other lower-cost producers who will capture export markets. Consequently, it is still too early to discern any definite trends in this market, other than to say that the potential for exports is very significant.

The aggregate effect of these three factors on the current account is an outflow of just over R200 million per annum at the peak of the programme, which is very insignificant in relation to current imports and exports. The balance of payments is therefore not likely to act as a constraint on electrification, even under the IEP scenario.

(ii) Fuelwood policies
The fuelwood policies proposed in EPRET are unlikely to have any direct impact on the balance of payments.

(iii) Low-smoke coal
The development of LSCs would probably have no direct effect on the balance of payments. The only possible effect would arise if a levy was imposed on the sales of all bituminous coal, including export sales. In this case, the export price would increase by about 1.2%, which, provided that export volumes would be unaffected by the price increase (which could possibly be offset by ongoing devaluations of the Rand), would result in additional foreign exchange inflows of about R50 million per annum. This is based on export volumes of about 49 Mt at prices of about R87 per ton (DMEA 1992: 27). Clearly, however, the goal of such a levy would not be to improve the balance of payments, and such effects would be incidental. In practice, it will be important to assess whether coal exports would be compromised on international markets before including them in the scope of this levy.

(iv) Gas and paraffin
There are unlikely to be any balance of payments effects associated with the policy proposals in this sector. Both LPG and IP are residual fuels in the local refining process and any change in consumption patterns (for example, an increase in LPG consumption), is unlikely to require any change in the refining mix and can be met with existing crude refining capacity.

(v) Demand-side management
DSM strategies will have limited direct effects on the balance of payments. Indirect benefits may flow in the longer term through reduced imports of capital goods associated with constructing additional power stations, or for imports of electricity from the region. On the other hand, there may some leakages in respect of the import of appliances such as compact fluorescent lights and solar water-heaters. CFLs are fully imported, so that, based on the assumptions made earlier, demand from already-electrified households may account for imports of about R240 million, and demand from new connections under the electrification programme, for R24 to R40 million worth of imported appliances.

4.5 Impacts on employment

The employment variable in the current context corresponds with a broad concern for improving equity. This is a complex issue which can be approached with varying degrees of sophistication. Unfortunately, estimates usually attract a certain amount of controversy on political and economic grounds. The analysis in this chapter is rather crude and probably represents the least optimistic end of the range of possible effects.

4.5.1 Scenario one: business as usual

(i) Electrification

Considerable debate surrounds the likely impact of electrification on employment levels. Some very optimistic estimates have been made, by De Wet et al (1989) from Pretoria University, of the employment benefits of a programme making 300 000 connections per year. Using input-output tables they estimated that electrification would have enormous employment effects (mostly in downstream sectors and due to higher personal consumption expenditure), with a minimum of 300 000 new jobs after five years, and up to 2 250 000 after 25 years. These figures, however, have been felt to be very optimistic, and amongst other problems, do not account for the over-capacity inherent in most economic sectors (Theron and van Horen 1992).

Research which has approached the question from the opposite angle – that is, from the perspective of particular firms in the industry and their current capacity utilisation and ability to expand – suggests that additional employment due specifically to electrification will be positive, although much lower (Baumann 1993; Goode 1993).

Employment may be affected in three areas:

Labour component of the electrification process:

This is an area in which considerable opportunities exist for transferring income to local communities through the use of local labour and the building of local capacity. However, for the purpose of the BAU scenario, it is assumed that relatively standard labour employment procedures are used. As noted earlier, labour costs comprise about 25% of average connection costs, excluding those labour costs which are included in overheads (design, management, administration). This amounts to about R750 per connection, or R187.5 million for a total of 250 000 connections (1993 Rands). Working on an average gross cost (per employee) of R30 000 per annum, this is equivalent to one additional employee for every 40 new connections. Assuming constant wages and labour productivity, this would amount to about 6 250 new jobs for 250 000 connections. In practice this may mean that fewer people lose their jobs, but either way employment spin-offs are important. Unfortunately many of these benefits will be transient, unless the temporary employment process also results in a transfer of skills which can subsequently be used to generate incomes.

Upstream of electrification itself, are the additional jobs created in materials suppliers. Once again, this sector is currently able to expand its output considerably without having to employ large numbers of new employees. The number of people employed in this sector is dependent to a greater extent on the overall level of economic activity and will not receive a massive boost from an electrification programme. It is estimated, from industry-specific research, that about 2 500 new jobs would be created to meet the additional demand for electricity materials (EDRC 1993: 13).

Together, therefore, about 9 000 formal jobs may result directly from the connection process itself under this scenario.

Labour effects in downstream industries – appliances:
New employment in the appliance sector will be limited in the short and medium terms, due mainly to the strength of overseas producers, and the low capital and labour productivity in local manufacturers. In fact, the industry is currently undergoing shrinkage with a shedding of labour to attempt to improve international competitiveness and so it would be imprudent to assume major employment opportunities exist here.

Informal employment opportunities:
This is an area in which electricity is likely to deliver enormous benefits, although these are also the most difficult to quantify. It is accepted that access to electricity can improve the potential for households to generate additional income from small-scale enterprises, such as beer-brewing, hairdressing, welding, and baking. Indeed, the experience in several newly electrified areas, particularly where electrification has been accompanied by other interventions such as improved access to credit, has been that the number of micro-enterprises has increased dramatically, with obvious benefits not only for those households' disposable incomes, but also for employment levels in the area. There is no definite basis for estimation of these effects, other than to assert that significant benefits will accrue to households.

On the negative side, electrification may cause a decrease in the demand for labour in the sectors in which consumption spending decreases as a result of electrification, such as coal, paraffin and gas. The effect on employment, however, is likely to be negligible, because the domestic sector accounts for a very small percentage of the total market in these products. Employment in these sectors is dependent to a far greater extent on the demand from their major customers. For coal these include export customers, electricity generation, synthetic fuel production and industry. IP and LPG are essentially residual products in the oil refining process.

On the whole, therefore, the impact on employment of a BAU electrification programme is likely to be positive, although not enormous. An order-of-magnitude indication of the number of formal jobs which might be created under this scenario is around 9 000. Informal sector activity, on the other hand, will be boosted by electrification, although the effect cannot reasonably be estimated. Over time, it can also be expected that more employment opportunities will present themselves in the maintenance and repair sector, both for appliances and the electricity distribution network.

(ii) Other supply and demand sectors (fuelwood, hydrocarbons, DSM)
As before, no major employment effects will result in these energy subsectors under the BAU scenario.

4.5.2 Scenario two: integrated energy planning

(i) Electrification
Again, this is a contentious issue on which many different estimates have been made. For present purposes, the same three categories of employment effects will be considered as under the first scenario.

Labour component of the electrification process:
As noted earlier, labour costs comprise about 25% of average connection costs, equivalent to about R750 per connection. Working on an average gross cost (per employee) of R30 000 per annum, this is equivalent to one additional employee for every 40 new connections. Assuming constant wages and labour productivity, this would amount to about 7 500 new jobs for 300 000 connections, rising to about 12 500 jobs at the peak of the programme in 1997. Whilst no detailed analysis has been done of these possibilities, it is also evident that the *process* of electrification could be such as to provide the affected communities with significant benefits from employment, subcontracting and involvement in decision-making processes and

responsibilities. Whilst this may compromise on the speed of the programme, it will certainly cause greater benefits to flow to communities themselves, in the form of income, skills acquisition, experience in development projects and institution-building. These aspects should be maximised, subject to maintaining a reasonable rate of progress with respect to new connections.

Upstream of electrification itself, additional demand will be encountered for the products and services of materials suppliers. As noted before, this sector is able to expand its output considerably without having to employ large numbers of new employees. Since there is not a linear relationship between output and the number of employees, this scenario may result in, say, half as many extra jobs for a doubling of output compared to the first scenario. This is equivalent to about 3 750 new jobs.

Together, therefore, about 16 000 formal jobs may result directly from the connection process itself under this scenario.

Labour effects in downstream industries – appliances:
New employment in the appliance sector will be limited in the short and medium terms, due mainly to the strength of overseas producers, and the low capital and labour productivity in local manufacturers. In fact, the industry is currently undergoing shrinkage with a shedding of labour to attempt to improve international competitiveness and so it would be imprudent to assume major employment opportunities exist here.

Informal employment opportunities:
As before, it can be expected that significant benefits will accrue in the informal sector through widened access to electricity. With a programme which aims to electrify over 85% of the population by 2010, it can be expected that these benefits will be highly significant. Unfortunately, because of the difficulty of measuring these impacts, no estimate will be made here as to the number of income-earning opportunities which might be facilitated by electrification.

On the negative side, electrification may cause a decrease in the demand for labour in the sectors in which consumption spending decreases as a result of electrification, such as coal, IP and LPG. The effect on employment, however, is likely to be negligible, for the reasons already given above.

On the whole therefore, the impact on employment of an electrification programme is likely to be positive, although not enormous. An order-of-magnitude indication of the number of formal jobs which might be created under this scenario is around 16 000. Informal sector activity, on the other hand, will be significantly boosted by electrification, although the effect cannot reasonably be estimated. Over time, it can also be expected that more employment opportunities will present themselves in the maintenance and repair sector, both for appliances and the electricity distribution network.

(ii) Fuelwood policies
The employment effects of the fuelwood policies proposed in this project are likely to be very favourable. In the first place, a better supply of fuelwood will significantly reduce the amount of time spent by women in the collection of fuelwood, and will therefore release that time for other purposes. Secondly, increases in employment and income-earning opportunities for rural people should result from expenditure on social forestry, woodlots and plantations, and small-grower schemes. Unfortunately, no detailed assessment has been made of the numbers of people likely to benefit from such programmes, although it is clear that many will benefit. The establishment of the network of 4 000 small nurseries will provide employment for at least double that number of people, while the establishment and management of 1 500 woodlots will probably employ a similar number of people. The small-grower schemes would likewise generate considerable amounts of in-

come for the small-scale farmers involved.

Consequently, these policies are likely to be more labour-intensive and employment creating than those from other energy sectors and this should be seen as a major boost for the development of rural areas where unemployment levels are high.

(iii) Low-smoke coal

A potentially important spin-off of the Enertek cement-based LSC is its potential to create employment and income-earning opportunities for large numbers of people. The estimates quoted in Chapter 3 suggest that individual production units, with about six workers using concrete-mixers, could produce about four tons per day, or 800 tons per annum. Assuming that half of the domestic coal market (that is, 1.5 million tons per annum) could ultimately be supplied by decentralised LSC producers, this would require about 1 875 similar production units, which would provide employment for just over 11 000 people. Moreover, the opportunities for such small-scale manufacturers would also increase considerably: for example, in the areas of brick and block production.

(iv) Gas and paraffin

A potentially negative result of the proposals around extending oil companies' involvement down the distribution chain, will be the loss of employment for the distributors or routers. It would be undesirable from an equity and employment perspective if large oil companies gained further market share at the expense of these small businesses. However, it has been proposed in EPRET Paper 14B that the incomes of these routers could be maintained by absorbing them into the oil companies' distribution networks. This is a sensitive area, which may require further investigation.

The current policy research (based at the MRC) around the production of child-resistant paraffin lids is oriented towards maximising the opportunities for the production of these lids within communities themselves, in much the same way as for LSCs. If the products can be designed so as to be produced on a small scale by local enterprises, then significant employment opportunities could be created.

(v) Demand-side management

No detailed analysis has been made of the employment effects of DSM policy options in South Africa, although it is possible that there may be reasonable benefits from a national programme to upgrade dwelling insulation performance. It is likely that these benefits would flow directly to households and communities themselves.

4.6 Impacts on environmental sustainability

Environmental sustainability is seldom considered as a criterion in conventional macro-economic analyses, except in the environmental literature where it obviously has a very high profile. It is included here, however, because of the importance attached to the three developmental goals of equity, efficiency and sustainability.

No index or easily-quantifiable measure exists upon which to base an assessment of changes in sustainability related to the present discussion. However, the household energy policy arena has important environmental interfaces, changes in which can be assessed either quantitatively or qualitatively. The perspective on 'sustainability' which is adopted here is therefore that of the quality of the immediate environmental conditions experienced by the poor. Whilst this perspective may not conform to a conventional understanding of 'sustainability', which usually refers to the manner in which resources are utilised, it is considered appropriate for the present context because the immediate environmental conditions of the poor should be the *first step* towards broader sustainability of an economy. Until the household environment is of adequate quality, it would be a misdirection of resources or effort to consider macro resource sustainability as usually defined.

4.6.1 Scenario one: business as usual

(i) Electrification

An electrification programme will have several positive and negative environmental effects. These have been considered in more detail in EPRET Paper 16 but, for present purposes, the following are important:

- The main negative effect would result from the additional electricity generated to meet demand from new customers. This would entail slightly more consumption of coal, emission of pollutants (such as sulphur dioxide) and carbon dioxide, and impacts on water and land environments. However, the marginal contribution to these negative effects which could be attributed to newly electrified domestic consumers will be very small in relation to the effects arising from electricity consumption by existing domestic, mining and industrial consumers.
- Improvements in environmental conditions can be expected insofar as consumers substitute electricity for coal, paraffin and wood. Rates of respiratory illness, paraffin-poisoning and burns may decrease. However, it is likely that a supply-oriented electrification programme would pay relatively little attention to the reasons for multiple fuel-use among households which have access to cheap alternatives to electricity such as coal and wood. Consequently, by not recognising that use of wood and coal would probably persist, possibly even with access to electricity, the environmental and health problems associated with their use would probably remain serious.
- Without any interventions to address the profile of electricity demand in poor households, it is likely that the 'peaky' consumption of newly electrified households would contribute further to the poor load factor on the national electricity system. DSM strategies do not form part of this scenario and efficiency gains and shifting of loads would therefore not materialise.

(ii) Other supply and demand sectors (fuelwood, hydrocarbons, DSM)

Under this scenario existing trends related to the fuelwood and hydrocarbon sectors would continue. Consequently, the social and economic costs of fuelwood collection would remain high, and in those cases where women spend increasing amounts of time collecting wood where supplies decrease, these costs would increase. Likewise, the effects on peoples' health due to continued combustion of coal and wood, as well as paraffin-poisoning, burns and fires, would remain problematic.

4.6.2 Scenario two: integrated energy planning

(i) Electrification

Many of the environmental benefits under the IEP scenario will accrue not from electrification *per se*, but from the way electrification is integrated into a range of other demand and supply policy options, such as the use of LSCs for certain end-uses. Nonetheless, an electrification programme of the scale considered in the present study will have several important environmental impacts in its own right. While these are detailed more fully in EPRET Paper 16, for present purposes the following are important:

- The main negative effect would result from the additional electricity generated to meet demand from new customers, as discussed in relation to the BAU scenario.

- Improvements in environmental conditions can be expected insofar as consumers substitute electricity for coal, paraffin and wood. Rates of respiratory illness, paraffin poisoning and burns may decrease. However, as noted before, electricity is not likely to substitute fully for coal and wood, and so greater benefits will be achieved through interventions aimed at those sectors, such as LSC and improved ventilation of wood fires.

- An important feature of the IEP scenario will be the emphasis on DSM strategies to improve the efficiency of, or even to conserve on, energy use. Benefits may accrue both to households, for example through the use of more efficient appliances with lower life-cycle costs, and to the electricity suppliers because of the more efficient use of their systems, resulting in lower peaks and better load factors. The latter will arise, for example, through an efficient multiple-fuel use package which will utilise coal or gas heaters instead of more expensive electric heating.

(ii) Fuelwood policies

It can be expected that the fuelwood policies proposed in this project will have a favourable impact on the rural environment. Social forestry initiatives such as agroforestry are generally sustainable in the context of their micro-environments, and will reduce the pressure on natural woodlands and the natural habitats they support. Thus, while fuelwood collection is only one cause among many of woodland denudation, afforestation approaches such as social forestry will have a very favourable impact on wood resources in rural areas. This is because social forestry delivers numerous other benefits to households over and above fuelwood, and therefore helps meet household needs for timber, poles, fruits, and herbal or medicinal products. Pressure on existing woodlands will be significantly reduced through interventions on the scale envisaged in the IEP scenario.

On the other hand, woodlot development, especially if this involves mono-crop plantations, can have negative effects on the surrounding environs through, for example, the displacement of the natural biological diversity found in savannah and natural woodland areas. In addition, water supplies can be affected through increased water uptake by plantations. Nonetheless, it is possible, with sensitive environmental management in the siting and operation of woodlots, to minimise any such negative effects.

A secondary spin-off of these interventions will be the slight amount of carbon dioxide which will be absorbed by these trees – assuming that the net amount of standing trees increases, or decreases at a slower rate due to these policies. However, this benefit will be marginal on a global scale, and should not be misconstrued as a justification for afforestation programmes.

(iii) Low-smoke coal

The use of LSC instead of normal coal would have two important environmental effects. Firstly, the levels of particulate matter to which people are exposed should decrease, particularly once LSC is widely used; indeed, this is the prime motivation for the development of this kind of fuel. Once these pollution levels are decreased, many secondary effects should result: reduced incidence of respiratory illness in exposed populations, reduced health care expenditure, and improved air quality in coal-burning townships where pollution levels are severe.

Secondly, the production of LSC would utilise a portion of the 40 million tons of coal wastes produced annually, carrying negative environmental and economic costs of their own. It is estimated that approximately four million tons of the total waste has a suitable energy content for use in LSCs. This would reduce the amount of waste to be otherwise disposed of, and would lower the risks of burning coal dumps.

Clearly, LSCs are not the definitive answer to all environmental problems as they still emit a number of gaseous pollutants, as well as carbon dioxide, a principal greenhouse-effect gas. Nonetheless, their use can result in significant environmental gains, particularly for the poor.

(iv) Gas and paraffin
The main environmental problem currently experienced with respect to these fuels is paraffin-poisoning. The explicit aim of the policy proposal for the production of child-resistant lids is to prevent this, and it is expected that a high percentage of such accidents could be avoided with the use of such lids – it is possible that the lids being currently designed could fit over 80% of the most commonly used paraffin containers. The problem of fires and burns is likely to be mitigated as electrification of households results in the gradual replacement of IP (and candles), which are associated with the highest number of such accidents.

(v) Demand-side management
Environmental considerations are a major motivation for embarking on energy efficiency programmes, the other being the economic gains which can be made. To the extent that these measures result in a saving of energy, whether electric, coal, wood or other, there will clearly be environmental benefits in the form of reduced emission of pollutants and greenhouse gases, reduced depletion of non-renewable coal reserves and of renewable wood resources, as well as improved quality of life for household members. Whilst these benefits have not been quantified, it is clear that they are significant.

4.7 Conclusion

A central reason for undertaking this assessment of the macro-economic effects of the policy proposals of the main sectors in EPRET was to assess their feasibility in the broader macro context. A second objective was to assess whether there will be any contradictions between the policies in various sectors, and between the policies and the three objectives of the present study: namely to improve equity in the household energy arena, whilst maintaining a balance with efficiency and environmental goals. Thirdly, there may also be an intellectual interest in the effects of the policies on the macro-economy, especially where the household energy sector is analysed in the context of the economy as a whole, or together with other sectors such as education, health and housing.

Based on the analysis in this chapter, it can be fairly safely concluded that the policy proposals in EPRET appear to be feasible within the context of the national economy, and that no major constraints appear to exist in the specific subsectors. Moreover, many of the policies proposed will have potentially significant positive effects on the economy, through the stimulation of productive investment. An important aspect of these effects include the environmental benefits which should result under an IEP scenario.

The policy sector of greatest macro-economic significance is the electrification programme, which has several impacts relevant at a macro-economic level, although the anticipated level of investment and government spending appear to be affordable. The impacts of these scenarios on the electricity supply industry, together with proposals around electricity tariffs and industry structure, are considered in more detail in Chapter Five.

CHAPTER FIVE

Impact of policy proposals on the electricity supply industry

5.1 Introduction

An important principle in the financing and pricing arenas is that the financial viability of the supply industry should be maintained, even when pursuing equity objectives. Of the major supply sectors, such as electricity, petroleum, fuelwood and coal, it is in the electricity supply industry (ESI) that the proposed policies will have the most profound impact on the financial viability of the industry; this chapter describes the possible financial impact on the ESI of some key policy options.

A financial model has been constructed which calculates the financial impacts of electrification scenarios, given a number of assumptions regarding most of the key variables which will affect the finances of the programme, such as connection rates, capital costs, tariffs and operating costs. The inputs to the model include all of these variables and more, while the main outputs are the annual cash flow and the cumulative financing requirement (which could be met through debt or equity financing). Additional outputs include the overall net present value of the programme and the internal rate of return. The detailed assumptions for various scenarios are described below.

5.2 Assumptions in the IEP scenario

For the purpose of this analysis the total population has been characterised according to *housing type*, and eight such categories have been identified. The data for each of these categories has been drawn from the EPRET data base, which has synthesised a number of sources as at 1990 (Trollip 1993). The data for 1990 has been updated for present purposes to 1993, by assuming the following:

- the total number of households grew by 300 000 during 1991 and 1992, which is equivalent to about 2% per year;
- in the absence of better information, it is assumed that these new dwellings were split equally between informal planned, informal unplanned and backyard shacks;
- a total of about 250 000 new electricity connections were made during 1991 and 1992, 70% of which were in low-income formal households, and the balance in planned informal dwellings.

In addition, since no information was available regarding the split between rural dense settlements and rural scattered (or dispersed) settlements, a 50:50 split was assumed.

Based on these sources of data and assumptions, an estimate of the number of houses in each category as at the beginning of 1993 is shown in Table 5.1. The number of houses in each category is an approximation only. Also included in Table 5.1 are the approximate percentages of each category which currently have access to electricity.

Housing category	No of houses 1993	Percentage access
High income formal	2 100 000	100
Low income formal	800 000	72
Planned informal	600 000	12
Unplanned informal	500 000	0
Backyard shack	700 000	17
Rural farmworkers	900 000	15
Rural dense	1 150 000	4
Rural scattered	1 150 000	1
TOTAL	7 900 000	39

TABLE 5.1 South African population segmented according to housing type in 1993, and percentage with access to electricity

This segmentation is necessary for electrification planning purposes, because there are significant differences in the connection costs and likely consumption patterns for each of these categories. For instance, it is probable that rural households will consume relatively small amounts of electricity since they will continue to use wood for some or all of their heating and cooking requirements. Likewise, the urban population has been segmented into two broad categories: those households which will consume relatively high amounts of electricity (using, for example, geysers and stoves), and those likely to use electricity only for such things as lighting, radio, television and a few small appliances. The class of long-electrified, wealthier consumers almost exclusively reliant on electricity constitute an important market segment, since it is a potential source of cross-subsidies for poorer consumer classes.

The financial model has been designed to allow for varying consumption patterns between these categories, as well as varying rates of connection. In practice, it is likely that certain categories will be electrified sooner than others, and so these broad sequencing trends have been incorporated into the model.

Several of the assumptions used in the base IEP scenario are shown in Table 5.2 for each of the housing categories. The variables include the average capital connection costs for each category, the initial monthly electricity consumption in kWh, and the maximum consumption. The latter is the level at which consumption stabilises, and is obviously also an average. Whilst it could be assumed simply that the annual connections are divided equally or proportionately among all unelectrified categories over time, the model is able to incorporate assumptions about the emphasis between categories over three time periods: the first and second five-year periods, and the third period of seven years (2004 to 2010). In other words, assumptions can be made about the percentage of total annual connections being made in each category. The table also shows the percentage access for each category which would result under this scenario by 2010.

From this table it is evident that the biggest category of houses to be electrified under the programme is planned shacks, which account for about 45% of annual connections. Under this scenario, the low-income formal housing category receives a significant amount of attention in the first five years, and then tapers off. The same applies to farmworker dwellings – which can probably be electrified fairly rapidly at low cost compared to other rural sectors. The converse applies to the other rural categories and to unplanned and backyard shacks.

Housing category	Capital cost	Initial kWh	Max kWh	Yrs 1-5 % total	Yrs 6-10 % total	Yrs 11-17 % total	2010 % access
High-income formal	0	800	800	–	–	–	100
Low-income formal	3 000	100	500	15	5	5	100
Planned informal	3 000	100	500	45	45	45	98
Unplanned informal	3 000	100	500	5	10	10	86
Backyard shack	2 000	80	200	5	10	10	74
Rural farmworkers	3 000	60	150	15	10	5	73
Rural dense	5 000	60	150	10	10	15	55
Rural scattered	7 000	60	150	5	10	10	52

TABLE 5.2 Assumptions regarding capital costs, consumption patterns and sequencing of connection for each housing category

A number of variables are common to all categories. They are as follows:

Monthly fixed service costs	R20
Annual growth in consumption	25%
Real discount rate	3%
Bulk supply costs	11.19 c/kWh
Technical losses	7%
Non-technical losses	5%
Provision for capital replacement	2%

It might be argued that fixed service costs will differ between categories, and, in practice, they would. However, it is also probable that they will be relatively comparable on average, since any excesses over the general cost of service parameter will be reduced either by negotiating a lower level of service, or by involving communities themselves in maintenance and service (or both).

Possibly the most important variable in this financial analysis, is the tariff level. To begin with, it is assumed that the status quo prevails insofar as new customers are charged on a basis similar to the current S1 tariff, and that there is no pooling of revenues and expenditures between electricity distributors. In this way, the financial impacts of the electrification programme can be assessed independently. Subsequently, the effects of national tariffs and revenue pooling will be included to determine the effect on the ESI.

5.3 Gross financing requirements of electrification

When the electrification programme is isolated from the other activities of the ESI, it is easier to assess its real financial costs. Based on the assumptions noted earlier, particularly those of the rate of annual connection, capital connection costs, consumption patterns, and at a tariff of 20 cents per kWh, the total financing requirement of the electrification programme over the 17-year period 1994 to 2010, would be in the region of *R22.4 billion* (in 1993 Rands). This financing requirement is shown in Figure 5.1 on an annual and cumulative basis.

It is evident from this figure that the programme will absorb a considerable amount of resources over its full duration and that, at a tariff level of 20c/kWh (in 1993 terms), the programme will continue to be a net absorber of funds, even in 2010 when the cashflow from the programme remains negative. This 'financing requirement' represents the amount which, all other things being equal, would have to be

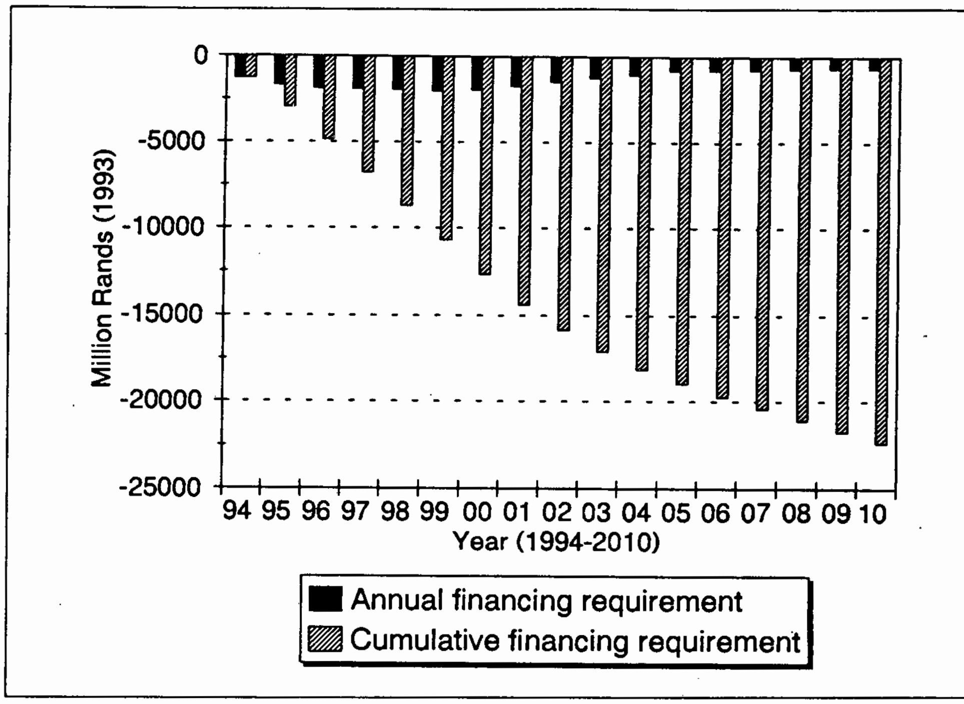

FIGURE 5.1 Annual and cumulative financing requirement of the electrification programme

financed by the ESI from one or other source. The two main kinds of finance available to the ESI (excluding external sources for now) include *debt* and *equity* finance. Clearly, if *all* of this were to be met through additional borrowings, then the risk exposure of the industry would increase dramatically, especially through the high finance charges which would result from the large capital debt. On the other hand, equity finance (in the form either of operating surpluses or direct private investment) also carries costs insofar as that finance could have been applied to other investments which would have earned a different rate of return.

It is useful to separate the financial flows taking place under the programme into two categories:

- the *capital cost* of investment in additional infrastructure: over the full period of the programme, this capital expenditure will amount to about R21.9 billion (corresponding to the figures referred to in Chapter 4); and
- the *operating losses and surpluses* resulting from the difference between revenue from consumers and expenditure incurred by supply authorities: by the end of the planning period, in 2010, the cumulative operating loss will be about R0.5 billion.

The latter point is significant: under the set of assumptions used in this analysis (especially with a tariff of 20c/kWh), the programme as a whole will not yet have reached break-even point with respect to operating costs, let alone capital recovery.

It is important, however, to disaggregate these cumulative figures further, and to identify trends in cashflows. Presenting the same data on the basis of *annual* cashflows, reveals that cashflows from operations turn positive in the eleventh year. The cumulative operating deficit therefore decreases after 2003. This is shown in Figure 5.2 .

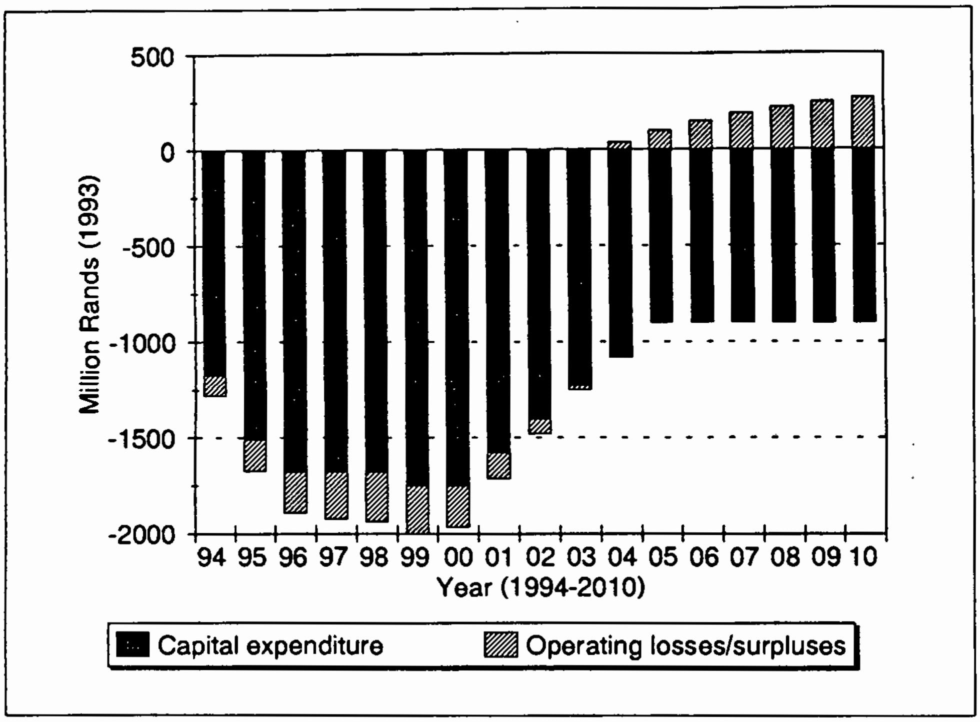

FIGURE 5.2 Annual capital expenditure and operating losses/surpluses of the electrification programme

On this basis, over a sufficiently long period, and at a very low discount rate, the electrification programme would yield a positive net present value (assuming capital expenditure ceases). Clearly, however, the payback period would be very long and, in practice, the cost of capital will be much higher than zero, thus discounting future (positive) cashflows more strongly.

Another interesting distinction can be made between the financing requirements of the rural and urban components of the programme, since these display very different characteristics. These are shown in figures 5.3 and 5.4.

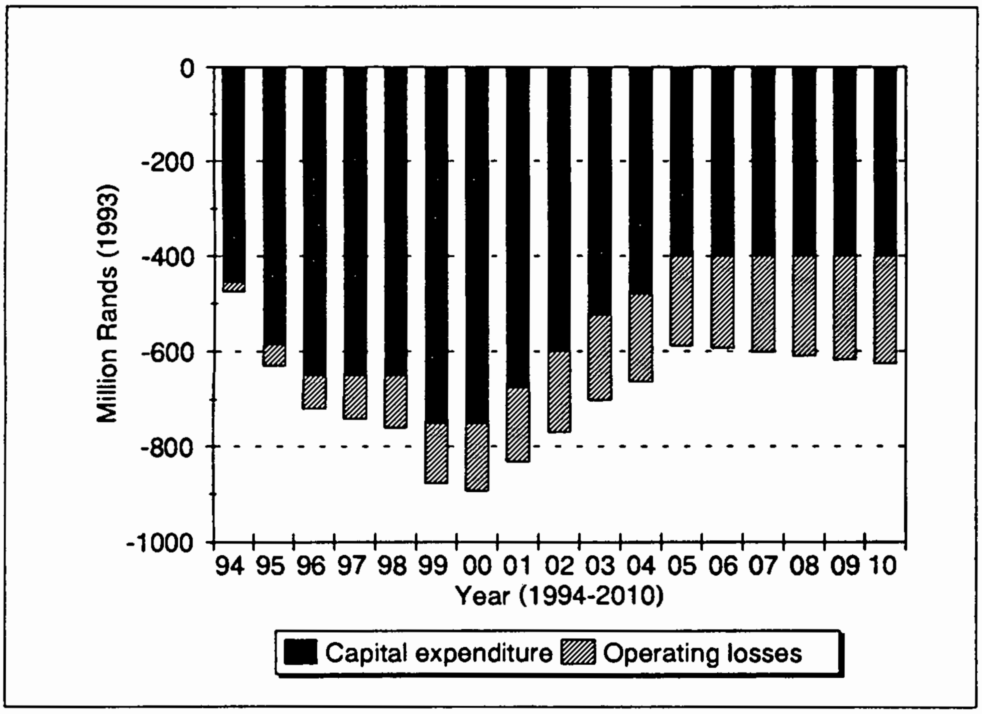

FIGURE 5.3 Annual financing requirement associated with the rural component of the programme

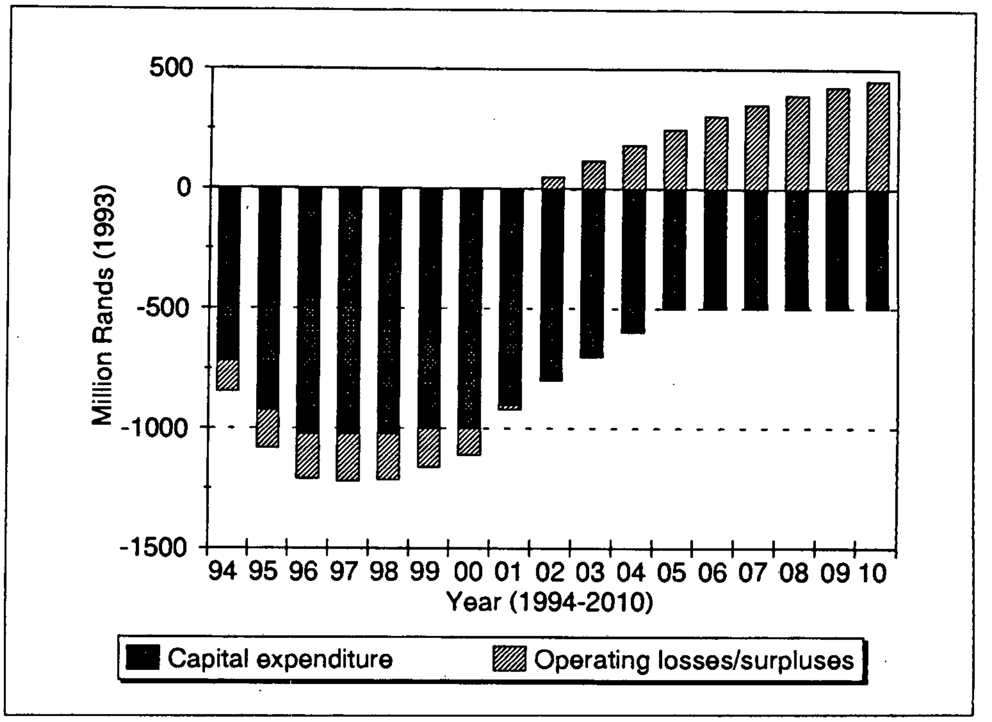

FIGURE 5.4 Annual financing requirement and contribution associated with the urban component of the programme

It is clear from these two figures that the rural electrification programme will have to draw upon resources from elsewhere for it to be sustained, whereas the urban component of the programme generates sizeable operating surpluses by the end of the period (almost R500 million per annum). Some of the possible sources of finance for the rural programme include cross-subsidies from urban households, non-domestic consumers, as well as direct grants from the fiscus. The financial impacts of these options will be described below.

5.4 Financial impact of electrification under the IEP scenario

Under the IEP scenario proposed in the EPRET project, there are two fundamental assumptions which affect the finances of the electrification programme:

- A *single national flat-rate tariff* applies to all of the consumer categories listed earlier. The most important implication of this is that the consumer class which has paid off its capital costs, and which generally consumes the largest amount of electricity ('formal high-income'), will be cross-subsidising the newly electrified classes. Depending on the tariff level, this can significantly reduce the total financing requirement for the ESI.
- The *distribution* function in the electricity supply industry is *rationalised*, such that surpluses generated from some domestic consumer classes are pooled and offset against any deficits from other consumer classes. In other words, either there is complete horizontal integration in the distribution industry, or there are equalisation mechanisms to transfer funds between regional distributors. It is assumed that all distributors apply the same tariff to their domestic customers.

With regard to these assumptions, in order to ensure that they are not unrealistic, it is assumed that the high-income domestic consumers who currently pay tariffs below the likely level of the national tariff, will move to the national tariff on a *phased* basis. Clearly, this involves a political process which may see resistance by some of these consumers to higher tariffs, although the negative impact on this group can be mitigated by phasing in their tariff increases over a number of years. From an income distribution perspective, the impact of a national domestic tariff would be progressive. Consequently, the analysis below assumes that there will be a real increase in their tariffs of 10% per year, until they reach the national tariff. From a base of 15.5c/kWh, it would take four years to reach a national tariff of 20c/kWh.

An important issue regarding this upward shift in price levels faced by high-income consumers, concerns their likely responses (if any) to the real price increases resulting from a move to national tariffs; in other words, their price-elasticities of electricity demand. If their demand for electricity is price-elastic, then there would be a proportionately larger decrease in their consumption levels in response to a price rise. This would have adverse implications from a financing perspective, since this consumer group is a major source of cross-subsidies. If, on the other hand, their demand is price-inelastic, they will not respond to a price increase by cutting back as significantly on consumption, and this portion of the supply industry's revenue base will be preserved. Unfortunately, there is not much information available on which to base any estimate of elasticities; for simplicity's sake it is therefore assumed that there will be no material decreases in electricity consumption by high income consumers. This is not unlikely in view of the probability that price increases will be more gradual (at least as suggested in this analysis). In addition, these households already own the large appliances and products in their homes which cause their consumption levels to be higher than average, and so general consumption patterns and lifestyles are not likely to change dramatically if electricity tariffs rise by about 30% over four years or so.

Based on the assumptions outlined earlier, and with a national tariff of 20c/kWh excluding VAT (or 22.8c/kWh including VAT), which is slightly lower than the present S1 tariff, the peak financing requirement will be reached after 11 years in 2004, at *R9.9 billion*. The financing requirements associated with the electrification programme will thereafter decrease, due to a positive net cashflow from the twelfth year, which rises to about R270 million by 2010. This is shown in Figure 5.5.

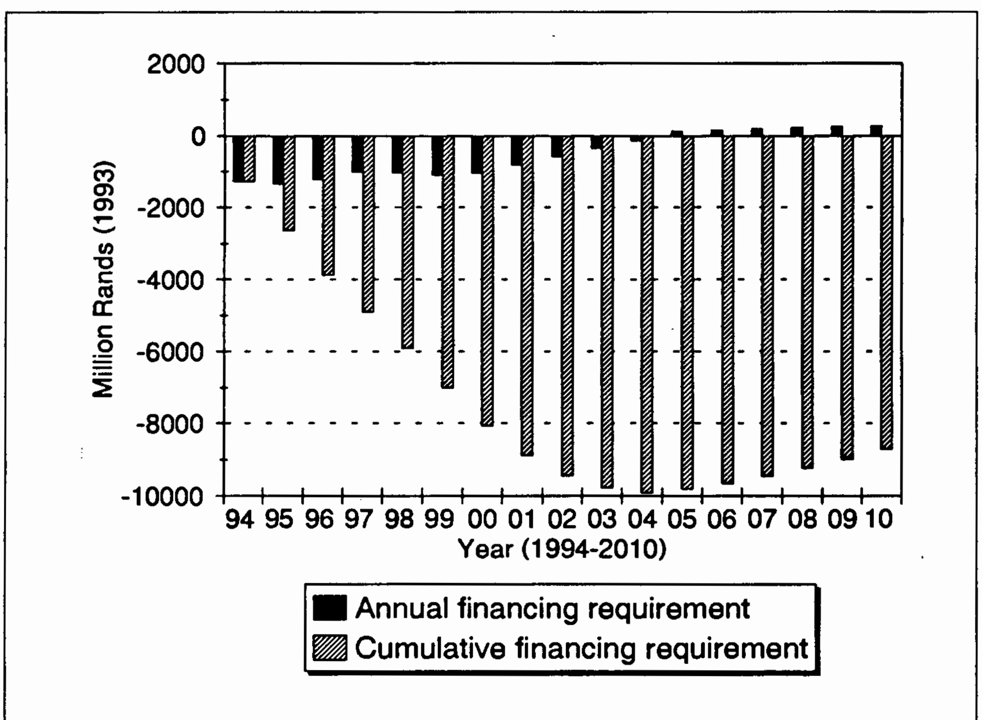

FIGURE 5.5 Cumulative and annual financing requirement of the electrification programme at a national tariff of 20 c/kWh with a phase-in of high-income formal households

The dramatic decrease in the financing requirement from R22.4 billion to R9.9 billion is attributable to the cross-subsidy from high consumption categories, which amounts to just under R1 billion per annum. This means that, with the phased pooling of their revenue, this group will contribute approximately R12.5 billion over the 17 years of the programme, which is equivalent to an average of just under R30 per month for each of these households. To place this total financing requirement in context, it can be compared with the financing requirement for a 3 600MW coal-fired power station in 1993 terms, which was estimated to be in the region of R10 to R12 billion (EDRC 1993).

Impact of an electrification levy

If, as suggested in Chapter Three, a levy is imposed on all electricity generated and is dedicated for electrification financing, this could further reduce the financing requirements for the ESI. Moreover, it would permit the national domestic tariff to be lowered, with all the favourable social and political implications this will have. An electrification levy imposed on generation or transmission, and equivalent to (for example) a 4% increase on the bulk supply cost, would raise just under R500 million per annum at current output levels. Assuming modest growth in electricity sales of 2% per annum over the period of the programme, this levy would generate R10 billion in additional finance for electrification. If these funds are channelled directly into an Electrification Fund and allocated to the electrification programme, as suggested, then the financing requirement to be met by the ESI will decrease to only *R4.6 billion* under the conditions described previously. As noted earlier, this will offer scope for reducing the domestic tariff. If the national tariff is set at *18c/kWh*, for instance, the financing requirement associated with the electrification programme would then be around *R9.2 billion*, although, as shown in Figure 5.6, the annual net cash flow by the end of the period would be fairly stable, just greater than zero.

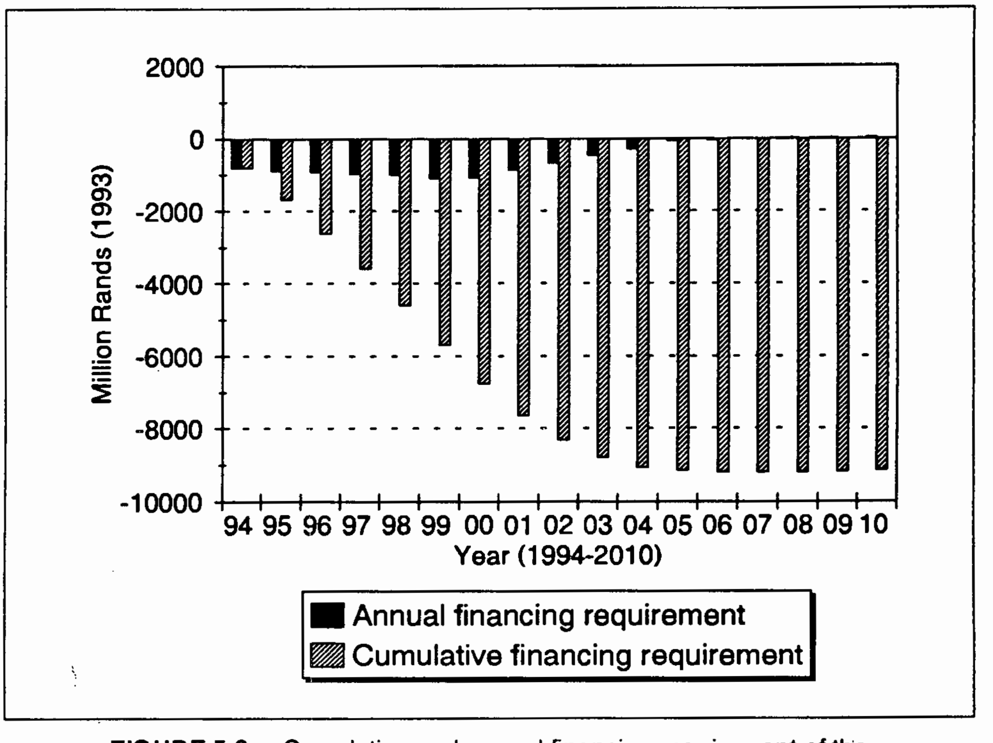

FIGURE 5.6 Cumulative and annual financing requirement of the electrification programme with an electrification levy of 4% and a national tariff of 18c/kWh with a phase-in of high-income formal households.

Impact of electrification on debt/equity levels

For purpose of the ensuing discussion, reference will be made to the financing requirement of the electrification programme *without* an electrification levy, with a domestic tariff of 20c/kWh, and with phased pooling of high-income consumers, as shown in Figure 5.5. In this case, the financing requirement amounted to R9.9 billion. This will be referred to as the 'base IEP scenario'. Even if the whole of this financing requirement is met through additional debt, then such a scenario would have a relatively easily-manageable impact on the debt levels in the ESI. If Eskom were to take on all of this debt (that is, as if there was one national distributor), then this would have a relatively small impact on its debt to equity ratio. Its current debt/equity ratio is about 2.2:1, while its goal is to reduce this to 1:1 by 1996/97 (Els 1993: 3). Assuming that retained earnings increase by a modest 8% per annum (in 1992 actual growth was 14%), then by 1998 equity will be in the region of R19.8 billion. At that stage the cumulative debt from the electrification programme will be just under R6 billion, which would cause the debt/equity ratio to increase from 1:1 (assuming Eskom achieved its target) to 1.30:1. Assuming that Eskom aims to maintain its debt at par with its equity after 1998 (excluding electrification), and if earnings continue to grow at 8% per annum, then at the peak of the electrification programme's debt requirement in 2004, the debt/equity ratio would be about R41.3 billion to R31.4 billion, or 1.32:1. Even at the peak of the programme, therefore, debt levels will be well below their present levels in relative terms.

The net present value of the cashflows associated with the electrification programme under the base IEP scenario yields a negative amount of R7.9 billion under this set of assumptions. Whilst this suggests that the programme is not viable over the 17 year period, and should not be pursued if evaluated according to narrow financial principles, it is also clear that the programme would yield a positive NPV over a much longer period since the cash flow is positive in the latter quarter of the programme. Moreover, the NPV analysis takes no account of the associated economic, political and social benefits of electrification, which make the exercise more desirable.

Conclusion

Under these assumptions, therefore, it appears that the electrification programme can be relatively easily managed by the ESI and that the ESI's financial viability will not be threatened. Clearly, this analysis makes a *ceteris paribus* assumption with regard to *external* variables: that all other things stay equal (for example, demand for electricity from non-domestic sectors grows sufficiently to provide Eskom with the anticipated growth in earnings, that excess generation capacity is allocated to currently unelectrified households, and so on). However, the variables which are *internal* to the ESI and the electrification programme will have a major influence on the finances of the industry – for example, tariffs, connection costs, consumption levels, and fixed service costs. The following section performs a sensitivity analysis on some of the key variables.

5.5 Sensitivity analysis

In order to test the sensitivity of the financial outputs to changes in the inputs, each of the major variables which are likely to change from the assumptions used in this analysis can be varied by 10% either way, and the impacts on peak financing requirement observed. The results of such an analysis are summarised in Table 5.3. Variances relating to operating costs have been included in this sensitivity analysis, since any changes in these costs will have significant impacts on the industry, which may not be reflected automatically and immediately in corresponding changes in the tariff.

Rank	Variable	Peak financing requirement (Rm 1993)	% Variance unfavourable/ (favourable)
	BASE IEP SCENARIO	9 914	–
	UNFAVOURABLE VARIANCES		
1	Tariff -10%	19 097	93
2	Bulk supply cost +10%	16 042	62
3	Connection cost +10%	11 562	17
4	Monthly fixed cost +10%	11 454	16
5	Consumption by high-income consumers -10%	11 373	15
6	Initial consumption -10%	10 382	5
7	Consumption growth -10%	10 257	3
8	Maximum consumption -10%	10 159	2
	FAVOURABLE VARIANCES		
1	Tariff +10%	6 257	(37)
2	Bulk supply cost -10%	6 374	(36)
3	Connection cost -10%	8 265	(17)
4	Consumption by high-income consumers +10%	8 505	(14)
5	Monthly fixed cost -10%	8 536	(14)
6	Initial consumption +10%	9 495	(4)
7	Consumption growth +10%	9 621	(3)
8	Maximum consumption +10%	9 722	(2)

TABLE 5.3 Sensitivity analysis of key variables in the electrification scenarios

From this analysis it is apparent that the level at which the flat rate tariff is set will have a profound influence on the financial status of the industry. A decrease of only 2c/kWh, to 18 cents per unit, causes the peak financing requirement to almost double, to R19 billion. The model's results show that even after 17 years of the programme, annual cash flows would be negative at this tariff level (in 1993 terms). Conversely, a 2 cent increase in the tariff to 22c/kWh would cut the financing requirement by over a third, to R6.3 billion. Bulk supply costs show a similar degree of sensitivity to changes in the tariff, as would be expected.

Of the remaining variables, three show similar sensitivities: capital connection costs, monthly fixed service costs and consumption levels of the high-income consumer class. The latter is clearly an important variable, since this group is a major source of cross-subsidy finance for the programme. Each of these variables reflect greater than unitary responsiveness: their elasticities are greater than 1. In other words, a 10% change in any of those variables results in a greater than 10% change in the financing requirement.

The last three variables, related to consumption patterns of new consumers, show relatively low sensitivities, causing variances in the financing requirement of less than 5%. This suggests that the financial results of the programme are relatively independent of consumption levels of new customers, which is a surprising result. This may be attributable to the fact that their consumption patterns have been isolated from those of long-electrified customers, who are much more significant as a source of revenue in the programme than new customers themselves.

It is clear therefore that the process by which tariffs are set in the industry is vitally important, and will determine whether the industry achieves its developmental objectives without undermining its long-term viability. This underscores the need for a strong and effective regulatory environment in the ESI which will govern the process of tariff-setting. The key issue will be to achieve a balance between social imperatives for lower tariffs, and economic and financial imperatives for higher tariffs which maintain the viability of the ESI in the long-term.

CHAPTER SIX

Impact of energy policies on household micro-economies

6.1 Introduction

Poor households typically spend a high proportion of their income on energy services and, while there are obvious dangers in attempting to make generalisations, it is not unusual for the poorest urban households to spend between 10% and 25% of their incomes on energy. Even in rural households, where fuelwood accounts for the largest part of the energy consumed and is by-and-large available at no cash cost, energy expenditure may still be significant where households use batteries, candles and paraffin. Moreover, where income flows tend to be erratic and highly variable, energy expenditures are not easily reduced, as evidenced by the relatively higher percentage of income devoted to energy by poor households.

The absolute amounts expended on energy vary widely, with most urban households probably falling within the range of about R30 to R100 per month. In rural households (where data is more scarce) energy expenditure is generally lower. Clearly it is not possible to generalise across the whole population, and it is not the objective of the present discussion to provide a comprehensive picture of current income distribution and energy expenditure patterns. Instead, the aim is to make an assessment of the likely directions and, where possible, orders of magnitude of changes in household energy expenditure patterns which may result from the policies proposed by EPRET. Consequently this chapter describes, in a qualitative manner, the possible impacts on household budgets of the main policy sectors addressed throughout this paper. Where sufficient data exists, and the result may be meaningful, these effects have been quantified.

6.2 Impact of electrification on household economies

Household economies will be affected differently depending on the range of fuels currently used, the extent to which electricity will replace those fuels, and the prices currently paid for energy services. Some of these impacts may be as follows:

- In the case of already electrified households in historically white areas, electricity tariffs will increase if a national flat-rate tariff is implemented. If this tariff is set at around 20c/kWh (excluding VAT) then the increase could be in the region of 4.5c/kWh for most customers in this category. For a household consuming 800kWh per month this will translate into a R41 (including VAT) increase in their monthly electricity bill, equivalent to a 30% increase. For those households electing to move to a time-of-use tariff, their electricity bill may then be reduced from this level if they are able to manage their demand patterns effectively.
- For newly electrified households consuming about 150kWh per month, expenditure on electricity would be in the region of R34, including VAT. This would be balanced by reduced expenditure on battery-charging, candles and paraffin and gas for lamps. Unfortunately, insufficient data exists to assess how much is currently expended on these services and how this compares to expected electricity expenditure.
- In the case of the more energy-intensive services such as cooking and heating, it is probable that the substitution effect of electricity will be smaller, since alternatives such as wood and coal will almost certainly be cheaper options for those households which have easy access to these fuels. Consequently there will be little change in expenditure patterns in most of these households.

- The better-off households, especially those in urban areas, are likely to make a more substantial shift to electricity, and will probably expend a greater portion of their budgets on electricity and electrical appliances than at present. These are households in which demand for electricity has been suppressed by their lack of access.

There are a number of other effects on households, which are social and environmental in nature, and which would have a less direct effect on household budgets. These effects include better quality of lighting at night, reduced time spent purchasing or collecting fuel, improved access to telecommunication services, and many more.

6.3 Impact of low-smoke coal (LSC) on household economies

The introduction of LSCs should not result in any additional expenditure by households currently using bituminous coal. If anything, LSC should trade at a slight discount on conventional coal if it is to achieve a significant penetration into the domestic market. Consequently, households should experience a direct decrease in their expenditure for the same quantity of coal. Of possibly more importance, however, will be the indirect effects of LSC use on households. Once there has been a substantial substitution of conventional coal by the low-smoke variety, it can be expected that peoples' particulate pollution exposures will decline and this should result in lower respiratory and other illnesses. This, in turn, may have a sizeable impact on the levels of health and medical expenditure, a portion of which is currently borne by households (and not the state), and which benefit would therefore accrue to them.

6.4 Impact of paraffin and gas interventions on household economies

Several policies have been proposed, with the aim of reducing the mark-ups in the later stages of the distribution and marketing chain for paraffin and gas. It appears as if some of these mark-ups are attributable not only to transport and handling costs, but also to profiteering, which, if reduced or eliminated, will result in significant savings to households using these fuels. According to McGregor's (1993) calculations, reductions in these retail price increases of 40c/litre of paraffin can be achieved. For households consuming 20 litres per month, a net saving of about R8 would result each month. Similar interventions in the LPG distribution chain could result in savings of 77c/litre (ibid). For household consumption of 10 kg per month, the corresponding saving would be almost R8 per month.

Another policy area which may have an indirect effect on household economies, relates to the use of child-resistant paraffin lids. Whilst the direct cost of these would be very low (around R1 each) and affordable for even the poorest households, the more significant impact on household expenditures patterns is likely to result from the *avoided* expenditure otherwise incurred when an incident of poisoning occurs: transport costs to a hospital or clinic, costs of medical care and medication and possibly lost income for parents who have to leave work or their own small-scale businesses. These benefits would accrue only to households which would otherwise have suffered additional expenditures, and will not *increase* their disposable incomes, but will nevertheless probably still be significant to those households otherwise affected.

6.5 Impact of fuelwood policies on household economies

The policies aimed at improving the supply and management of fuelwood resources are unlikely to have any major effect on household budgets in the short-term. Small additional amount may be expended on the purchase of young trees from nurseries for planting by individuals or groups of households, but these will probably be insignificant. If anything, future expenditure on commercialised fuels such as paraffin, and including wood, may be avoided or delayed if the depletion of wood resources is slowed through such policies.

It is also possible that households which engage in agroforestry and other social forestry practices may experience income benefits, through, for example, the sale of fruit and other products grown by them. On the whole, however, it is unlikely that fuelwood policies will result in any major changes in the income patterns of poor rural households, which are generally centred around remittances, pensions and farming incomes.

6.6 Impact of demand-side management (DSM) policies on household economies

It is probably fair to generalise that many DSM interventions entail a relatively large cash outflow initially, in return for lower subsequent cash outflows. This is the case, for example, with efficient appliances such as compact fluorescent light (CFL) bulbs, which have a higher capital cost but a lower operating cost. Consequently, where financing mechanisms can be employed to remove the initial barrier to entry imposed by high capital costs, then households may experience real savings in their energy expenditure in every period over the life-cycle of the product. This applies not only to policy proposals around the use of energy efficient appliances such as CFL bulbs, but also to options such as the fitting of ceilings and insulating material to poorly-insulated households. If the initial costs can be financed by energy utilities, retail or other institutions, then it is possible that households will experience immediate benefits, since the reduction in energy expenditure should be sufficient to more than offset the repayment of the loan and finance charges.

Another important DSM policy proposal which was mentioned earlier, is around the implementation of time-of-use tariffs in households which are able to shift significant portions of their load out of peak hours. This tariff system should result in direct savings to households which attempt to economise on electricity use – using geysers, for example, outside peak times. (Solar water-heaters will become more cost-effective for households with geysers if tariffs reflect the real costs of providing electricity to heat water during peak hours via the national grid.)

6.7 Conclusion

On the whole, it should be apparent that the EPRET proposals would result in real benefits to the poor households which are their target. Many of these benefits will be translated into reduced expenditure on energy and other services such as medical care, which will therefore release some income for different purposes related to energy services as well as other needs.

An exception to this generalisation will arise if a national flat rate tariff is implemented for all electricity consumers, in which case that consumer class which currently pays lower tariffs will clearly pay a premium for their electricity. This is an issue closely tied up with broader debates in the South African political arena around redistribution and equity.

CHAPTER SEVEN

Concluding summary

This paper has described the financing and economic impacts of the household energy policies emanating from the Energy Policy Research and Training Project. In doing so, it is hoped that it will have become clear that, although the policy proposals have significant investment requirements, it is not unrealistic to suggest that they are affordable to the national economy and its components. In other words, it is possible to implement a national household energy policy which will bring about a real improvement in the living conditions of the poor, by widening their access to adequate and affordable energy services.

As noted in the introduction, this paper had two main objectives:

- to assess the financing requirements of policy proposals in the main energy sub-sectors and to propose ways of mobilising and allocating finance where this is required, and
- to assess the potential impacts of policy proposals on important macro- and micro-economic variables, in order to ensure the consistency of policy proposals with broader macro-economic and development policy conditions.

The first of these objectives formed the basis of Chapter Three (Current financing arrangements and policy proposals in energy sub-sectors), while the second objective was addressed by Chapters Four to Six, which assessed the impacts of proposed policies on the national economy, on the electricity supply industry, and on household micro-economies.

The paper began by contextualising energy investment and expenditure in the macro-economic and micro-economic environments currently operating in the South African energy sector. It was noted that increases in government expenditure as a whole, or specifically on social services are unlikely to occur or to provide scope for additional energy expenditure. However, there is considerable scope for re-allocations within the existing budget grant to the Department of Mineral and Energy Affairs, and in particular from the nuclear industry to development sectors such as electrification and fuelwood-related policies.

In Chapter Three, the financing arrangements for each of the main policy sectors were addressed. These sectors include electrification, fuelwood, low-smoke coal, gas and paraffin, and demand-side management. The case of electrification received additional attention because of the need to raise additional sources of finance for a national electrification programme, and to allocate grant finance in the most equitable and effective means possible. Consequently, proposals were made around the establishment of an Electrification Fund, which would have as its goals the raising and allocation of finance specifically for electrification. In the cases of fuelwood policies. low-smoke coal development, gas and paraffin, and demand-side management strategies financing requirements are more modest, but are significant in their specific contexts.

Chapter Four contained an assessment of the impacts of two household energy scenarios on five macro variables: investment levels, fiscal revenue and expenditure, the balance of payments, employment and environmental quality. The latter two variables, whilst not always included in such analyses, are considered relevant in the light of the importance attached to equity and environmental sustainability objectives. This assessment was done for two macro scenarios: a business-as-usual scenario in which current trends in the energy sector continue, but without any major intervention, and secondly an integrated energy planning (IEP) scenario in which policy proposals aimed at widening households access to energy services are implemented. The results indicated that several of the policy proposals would have impacts which were not insignificant on a national scale, although in no case were the adverse impacts of such as a scale as to present real constraints on policy implementation. On the other hand, it was shown that many of the policies were likely to have significant positive effects, on, for example, employment levels and environmental quality.

The following chapter then considered the impact of the IEP policy scenario on the electricity supply industry. This sector was singled out because of the significance of the impacts of pricing, financing and governance policy proposals on the industry. A model which was developed for this purpose was used to quantify the financial impacts on the industry, and to assess the sensitivity of the outcomes to changes in the most important variables. It was highly significant that the effect of cross-subsidisation from high-consumption domestic customers to newly-electrified and low-consumption customers could be to reduce the peak financing requirement of the electrification programme to less than R6 billion if tariffs are set at around 20 cents per kWh (excluding VAT). The sensitivity analysis showed that changes in the tariff level will have a profound effect on the total debt levels resulting from the programme.

In Chapter Six, some of the potential impacts of policy proposals on household micro-economies were considered. This was a much more qualitative analysis than those which preceded it, because of the relative absence of data on household incomes and energy expenditures, and because of the wide variances which occur across space and time. It was suggested, on the basis of identifiable trends and impacts, that the EPRET policy proposals will have a positive impact on the economies of the poor, thereby contributing towards the principal policy objective – to widen access to adequate and affordable energy services for the urban and rural poor.

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PROJECT DESCRIPTION

A major two year research project was launched by the Energy for Development Research Centre in April 1992. It aims to investigate policy options for widening access to basic energy services for the urban and rural poor in South Africa. Research papers are being produced in the following areas:

Background papers
Research outline
Integrated energy planning: a methodology for policy analysis and research
Development context for energy planning in South Africa
Background on South African energy system

Energy demand analysis
Energy demand in underdeveloped urban and rural areas

Rural areas
Energy for rural development: an introduction and overview
Energy and small-scale agriculture
Rural household energy supply options
Afforestation and woodland management
Remote area power generation options

Urban areas
Household energy supply in formal and informal urban settlements
Energy and informal sector production

Ancillary sector
Energy and mass transportation*

Key supply sector
Electricity distribution sector*

Cross-sectorial studies
Energy efficiency and conservation*
Energy and environment*
Southern Africa linkages*
Investment requirements and financing mechanisms*
Pricing policy*
Institutional analysis*

Policy options
A concluding document will draw together key policy conclusions
** The scope of these studies is restricted to energy issues concerning the urban and rural poor.*

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- transferring relevant information to user groups by offering consulting services and running workshops, and through publishing books, journal papers, reports, leaflets and design and user manuals.

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PAPER Nº 18

Financing and economic implications of household energy policies

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SOUTH AFRICAN ENERGY POLICY RESEARCH AND TRAINING PROJECT

widening access to basic energy services for the urban and rural poor

ENERGY FOR DEVELOPMENT RESEARCH CENTRE
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